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The Engineer

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Increased Brake Power for Passenger and Freight Trains.

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, REQUIRES :—

WHEELS and AXLES, Disc Type, 224 PAIRS.
Tenders due 2 p.m. on the 17th July, 1923.
Tender forms obtainable from above. 2853

Architectural Assistant REQUIRED by the GOVERNMENT of HONG KONG for service as an Engineer in the Architectural Office of the PUBLIC WORKS DEPARTMENT for a period of 3 years, with possible permanency. Salary £460 per annum, rising by annual increments of £30 to £500, and thence (if appointment is made permanent) to £950 per annum. The salary is converted into dollars at the Government rate of exchange, at present fixed at 2s. to the dollar. This rate is open to revision. A conveyance allowance of $40 dollars per annum. Free passages provided. Candidates, unmarried, 25 to 30 years of age, must be architects' duly qualified assistants and belong to the R.I.B.A. Must be conversant with all the usual preparation of sketch designs and working drawings, specifications, quantities, measuring, &c., in connection with new buildings, additions and alterations. They should also have had experience in the design and execution of steel and reinforced concrete structures. Some experience in the maintenance of buildings is also desirable and municipal experience preferred.
Apply at once, by letter, stating age, qualifications, and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/11,988. 2879

Wanted at Once, Temporary ENGINEERING ASSISTANTS with good experience in design of Docks and Heavy Masonry; also ASSISTANT experienced in design of Reinforced Concrete Wharves. Preference given to ex-Service men.
Apply, giving full particulars of experience, age, salary required, when disengaged, and enclosing copy of recent testimonials, to CIVIL ENGINEER-IN-CHIEF, Admiralty, S.W. 1. 2772

Tank Pilots.
A limited number of VACANCIES for QUALIFIED MEN, to be APPOINTED to WARRANT RANK, EXIST in the TANK CORPS of the REGULAR ARMY. Candidates must be in possession of either :—
(i.) Associate Membership Examination of the Institution of Mechanical Engineers with its exemptions (to include Whitworth Prizemen).
(ii.) National Certificates (Higher) or National Diplomas (Higher) of Mechanical Engineering issued by the Institution of Mechanical Engineers in conjunction with the Board of Education (England and Wales).
(iii.) Diplomas of the Royal Technical College, Glasgow, or of the Heriot Watt College, Edinburgh.
Candidates must have also had a normal 4 years' manual apprenticeship.
Age limits 21 to 26 (30 in the case of men with previous service in His Majesty's Forces). Married men over 26 years of age are eligible. Pay £219 per annum and marriage allowance for married men who are accepted. Free food, clothes and lodging or allowances instead.
Candidates who are accepted will be enlisted in the Regular Army for a period of 3 years with the Colours and will be given immediate promotion to warrant rank.
Candidates, on completion of service, will, if desirous and recommended, be appointed to commissions in the Regular Army Reserve of Officers.
Applications, accompanied by qualifications, should be addressed to the COMMANDANT, Tank Corps Centre, Bovington Camp, Wool, Dorset. 2851

UNIVERSITY OF DURHAM.
Armstrong College,
NEWCASTLE-UPON-TYNE.
LECTURER IN MECHANICAL ENGINEERING.
The Council of Armstrong College invite APPLICATIONS for a LECTURESHIP as above. Salary £300-£350, according to qualifications. University degree or equivalent. Duties commence 1st October, 1923. Lecturer required to teach Mechanical Drawing, supervise work in laboratories and undertake preparation of necessary drawings. Practical experience essential. Ten copies of application and of not more than three testimonials must reach the undersigned not later than 21st July, 1923.
J. Y. T. GREIG, Registrar.
2872 Armstrong College.

University of London: University College.
DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING.
The University College Committee will shortly APPOINT an ASSISTANT LECTURER in THEORY of STRUCTURES and STRUCTURAL DESIGN.
Commencing salary £460.
Applications not later than 16th July, 1923.
Particulars may be obtained from the undersigned.
WALTER W. SETON, Secretary.
University College, London, (Gower-street, W.C.) 2856

University of Leeds.
CHAIR OF MINING.
The PROFESSORSHIP of MINING in the University will fall VACANT at the end of the present Session upon the resignation of Professor Granville Poole. A new appointment, taking effect on the 1st October, 1923, will be made in due course. The salary attached to this appointment will be £1000 a year. Further information may be obtained from the REGISTRAR, The University, Leeds. Inquiries should reach him not later than the 9th July. 2826

West Ham Municipal College,
ROMFORD-ROAD, STRATFORD, E. 15.
APPLICATIONS are INVITED for the POST of full-time ASSISTANT TEACHER in the Department of Engineering from candidates with University Degree and works experience. Salary in accordance with the Technical Burnham Scale for the London area, less 5 per cent., and subject to deduction for superannuation.
Forms of application may be obtained from the Principal, and should be returned not later than the 5th July, 1923.
GEO. E. HILLEARY, Town Clerk.
2751

PUBLIC NOTICES

County Borough of Blackburn.
ELECTRICITY DEPARTMENT.
The Electricity Committee have for IMMEDIATE DISPOSAL and REMOVAL the following STEAM and ELECTRICAL PLANT :—
Lot
1. FIVE LANCASHIRE BOILERS, by Yates and Thom, 35ft. by 8ft. 6in., insured with M.S.U.A. for 185 lb. working pressure, complete with Hopkinson fittings and McPhail superheaters.
2. TWO COMPOUND BOILER FEED PUMPS, by J. P. Hall and Sons, size 8¼ by 13½ by 8¼ by 18in. stroke, 5000 gallons per hour.
3. ONE BOILER FEED PUMP, by G. and J. Weir, 8in. by 10½ by 18in., capacity 4500 gallons per hour.
4. TWO Rellim-Siemens Steam-driven D.C. GENERATORS: Engine, 200 H.P. compound, 115 lb. pressure, 380 r.p.m.; Dynamo, bi-polar, compound wound, double wound armature, will run in parallel or in series at 240 or 550 volts.
5. TWO Rellim-Mayor and Coulson Steam-driven SETS: Engine, 400 H.P. 3-crank enclosed vertical tandem, compound type, 115 lb. pressure; Dynamo, multipolar, compound-wound type, voltage 460/550, 256 K.W.
6. ONE Steam-driven ALTERNATOR: Engine by Willans, 3-crank compound type, 333 r.p.m., 115 lb. pressure; Alternator by E.C.C., 1-phase, 50 cycles, 200 K.W.
7. ONE 440 Rellim-Siemens D.C. 500 K.W. SET, 440-500 volts, 3-throw compound.
8. ONE 440 K.W. MOTOR GENERATOR SET, by British Westinghouse, 475 B.H.P., 500/550 volts one side, 440/460 volts other side.
9. ONE 300 B.H.P. MOTOR, by Bruce Peebles, 1906 design, 440 volts, compound wound, multipolar, D.C., speed 240/312 r.p.m., shunt regulator open type, 3 bearings, no pulley, slide rails and starting switch.
The highest or any Tender will not necessarily be accepted.
The Corporation are open to consider offers for the above plant, and Tender forms and particulars can be obtained from Mr. F. P. WHEELWRIGHT, Borough Electrical Engineer, Jubilee-street, Blackburn. 2873

County of London.
The London County Council invites QUOTATIONS for the PURCHASE and REMOVAL of the undermentioned MACHINERY &c.:—
At ABBEY MILLS PUMPING STATION, ABBEY-LANE, STRATFORD, E. 15:
TWO HORIZONTAL DUPLEX TRIPLE-EXPANSION DIRECT-ACTING PUMPING ENGINES, 14¼in., 22in. and 33in. cylinders and 36in. ram, 4ft. stroke.
THREE LANCASHIRE BOILERS, 30ft. long by 8ft. diameter.
ECONOMISER of 120 tubes.
At NORTHERN OUTFALL WORKS, EAST HAM, E. 6 (Alongside Beckton Gasworks):
THREE LANCASHIRE BOILERS, 25ft. long by 6ft. diameter.
TWO VERTICAL TANDEM COMPOUND ENGINES, 12in. and 22½in. cylinders, 14in. stroke, each with 17in. CENTRIFUGAL PUMP.
TWO CONDENSERS, each about 7ft. long by 3ft. diameter.
FOUR GABBET'S MIXERS.
THREE WROUGHT IRON or STEEL TANKS, viz., Two 34ft. by 30ft. 3in. by 6ft. 9in. deep, and One 16ft. by 14ft. by 6ft. deep.
A QUANTITY of CAST and WROUGHT SCRAP.
Forms for Quotations, conditions of sale and full particulars may be obtained on application to the Chief Engineer at the Old County Hall, Spring-gardens, S.W. 1.
Quotations must be addressed to the Clerk of the Council and must be delivered at the County Hall, Westminster Bridge, S.E. 1, not later than 4 p.m. on Thursday, 12th July, 1923. No Quotation received after this time will be considered.
The Council does not bind itself to accept the highest or any Quotation.
JAMES BIRD, Clerk of the London County Council.
2865

PUBLIC NOTICES

County Borough of Reading.
The Corporation of Reading invite TENDERS for the CONSTRUCTION of a COVERED CATTLE SALE RING at their Cattle Market in Great Knollys-street.
Drawings and general conditions may be seen and specification, schedules and form of Tender obtained on application at the office of the Borough Surveyor, Town Hall, Reading.
Each application must be accompanied by a deposit of One Guinea, which will be returned to persons who send in bona fide Tenders on the forms provided. Cheques should be made payable to the Borough Accountant, Reading.
Sealed Tenders, in the endorsed envelopes provided, must be delivered to me at my office, situate at the Town Hall, Reading, on or before the 16th July, 1923.
The person whose Tender is accepted will be required to enter into a contract for the execution of the works and to give security for the due performance thereof.
The Corporation do not bind themselves to accept the lowest or any Tender.
Dated this 20th day of June, 1923.
C. S. JOHNSON, Town Clerk.
Town Hall, Reading. 2858

County of London.
The London County Council invites TENDERS for the MANUFACTURE, SUPPLY, DELIVERY, &c., and MAINTENANCE of 200 SETS of TRAMCAR MOTORS, with ACCESSORIES as specified, to complete the electrical equipment of bogie tramcars, and their ASSEMBLY in readiness for service operation on bogie tramcars, which will stand for the purpose at one or more of the Council's car sheds or depots in London, as may be determined upon.
The specification, form of Tender, and other particulars may be obtained on application to the General Manager, London County Council Tramways, Victoria Embankment, W.C. 2, on or after Monday, 2nd July, 1923, upon payment of a fee of £2. This amount will be returnable only if a bona fide Tender is submitted and not withdrawn.
General particulars of the work may be obtained at the Tramway Offices, Victoria Embankment, before payment of the fee.
Any samples or drawings referred to in the specification can be inspected by appointment with the General Manager after payment of the fee referred to above.
Tenders must be addressed to the Clerk of the Council and delivered at the County Hall, Westminster Bridge, S.E. 1, not later than 4 p.m. on Monday, 16th July, 1923. No Tender received after that time will be considered.
The Council does not bind itself to accept the lowest or any Tender.
JAMES BIRD, Clerk of the London County Council.
2840

Stoke and Wolstanton Union.
TENDERS (provisional) are INVITED for the INSTALLATION of a HEATING and HOT WATER SERVICE at the Turnhurst-road Institution situate at Chell, near Tunstall, in accordance with a specification prepared by Messrs. Edwards and Shaw, Consulting Engineers, of Birmingham. Copies of the specification may be obtained from the undersigned upon deposit of the sum of Three Guineas (to be returned upon receipt of a bona fide Tender), and a plan may be seen at these offices. Contractors will be required to conform to the usual fair wages and sub-letting conditions, and should state whether they are entered on the King's Roll.
Tenders, sealed and endorsed, to be delivered to the undersigned before Noon on Wednesday, the 11th July next.
Neither the lowest nor any Tender will necessarily be accepted.
T. WOOD, Clerk to the Guardians.
Union Offices Stoke-on-Trent, 23rd June, 1923. 2848

PUBLIC NOTICES

State Electricity Commission OF VICTORIA.
TENDERS FOR PLANT.
TENDERS are hereby INVITED for the SUPPLY of the following MATERIAL for the Morwell Power Scheme.
Copies of Tender form and specification, &c., will be available for inspection and purchase upon application to
The Agent-General for Victoria, Melbourne-place, Strand, London, W.C. 2.
SPECIFICATION NO. 23/32.—TRANSFORMERS.
CHARGE.—10s. for two copies of Tender form specification, contract conditions, &c., complete. This charge will be returned on receipt of a bona fide Tender.
A third or any further copies will be supplied for the sum of 5s. each, but this charge is not returnable.
PRELIMINARY DEPOSIT.—A preliminary deposit of £50 is required to be lodged with each Tender.
The Commission does not bind itself to accept the lowest or any Tender.
Tenders, on prescribed forms, properly addressed and endorsed, must be delivered to the undersigned in Melbourne not later than Noon, 25th August, 1923.
E. LIDDELOW, Secretary, State Electricity Commission of Victoria, Melbourne, Victoria, Australia.
2798

The Bengal and North-Western RAILWAY COMPANY, LIMITED.
The Directors are prepared to receive TENDERS for the SUPPLY of :—
800 HELICAL and 2000 VOLUTE SPRINGS, as per specification to be seen at the Company's offices.
Tenders, addressed to the undersigned and marked "Tender for Helical and Volute Springs," are to be lodged not later than Noon on Friday, the 20th day of July, 1923.
For each specification a fee of 10s. will be charged, which cannot under any circumstances be returned.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board, E. A. NEVILLE, Managing Director.
237, Gresham House, Old Broad-street, London, E.C. 2.
21st June, 1923. 2836

Bombay, Baroda and Central INDIA RAILWAY.
CHARGEMEN FITTERS FOR RUNNING SHEDS.
The Directors are prepared to receive APPLICATIONS (by letter only) from properly qualified candidates for APPOINTMENT as CHARGEMAN FITTER for the Running Sheds in the Locomotive Department of the Company in India.
Applicants must have served an apprenticeship in the sheds or shops of an English railway and have had subsequent experience as a Shed Fitter or Shed Chargeman on running repairs to engines, and in addition to simple machine shop practice and fitting work, should be able to straighten frames, try engines over for square, and set valves. Single men preferred. Age about 26 years.
SALARY.—Rs. 375 per calendar month.
TERMS.—A three years' agreement in the first instance, second-class free passage to India, and home again, subject to satisfactory termination of services.
The selected candidates will only be appointed subject to their passing a strict medical examination by the Company's Consulting Physician.
Candidates must send in a full record of their general and technical education and training, giving details of the shops or departments worked in and the class of work employed upon, with dates, together with copies only of any testimonials. Service certificates, &c., to the undersigned not later than the 13th July, 1923.
S. G. S. YOUNG, Secretary.
Offices: 91, Petty France, Westminster, S.W. 1.
26th June, 1923. 2837

The Commissioners for the PORT OF CALCUTTA.
APPLICATIONS are INVITED for the POST of ASSISTANT ELECTRICAL ENGINEER. Salary Rs. 700 per mensem, rising by annual increments of Rs. 50 per mensem to Rs. 1050 per mensem. The candidate must possess good technical qualifications, and a concise statement of these must be made in the application. Experience in the installation and maintenance of high-tension and low-tension switchgear, transformers, motors, underground cables and overhead transmission lines is essential.
Applications, with copies of testimonials, should be sent to Mr. J. ANGUS, M. Inst. C.E., Clutha House, 10, Princes-street, Westminster, not later than 10th July, 1923. 2854

"THE ENGINEER" WANTED.
WANTED, a COPY of "THE ENGINEER" Dated February 6th, 1920.—Address, P1000, The Engineer Office. P1000

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SITUATIONS OPEN

WANTED for Large Firm of Crane Makers, REPRESENTATIVE, to Take Charge of London Office. One having good connection and capable of interviewing and discussing projects and who can influence new business. State age, salary and experience.—Box No. 41, Macrae's Advertising Agency, 90, Hope-street, Glasgow. 2876 A

WANTED, MACHINERY INSPECTORS; Must be fully qualified and conversant with all classes of Chemical Plant, Engines, Boilers, Machine Tools, Electrical Plant, Rolling Stock, &c.—Write in first instance, giving fullest details of previous experience, covering at least fifteen years, references and salary required, to GEORGE COHEN and ARMSTRONG DISPOSAL CORPORATION, Abbey House, Victoria-street, S.W. 1. 2870 A

WANTED, WORKS MANAGER, by Firm of Boilermakers. None but first-class, up-to-date and progressive men need apply.—Address, stating age, experience, in the first instance, 2847, The Engineer Office. 2847 A

BIRMINGHAM MANUFACTURERS REQUIRE WORKS ACCOUNTANT with knowledge of Costing and commercial experience; public school education preferred. Progressive appointment for capable man.—Write, stating age, experience, and salary required, to GIBSON and ASHFORD, 89, Waterloo-street, Birmingham. P7640 A

BRITISH EAST INDIES.—REPRESENTATIVE WANTED, to travel in General Engineering Stores, including Motors and Accessories. Applicants must be of good address, energetic, single and had previous experience. Healthy climate. Salary and commission.—Write, giving brief particulars, salary expected, &c., Box G758, Lee and Nightingale, Advt. Offices, Liverpool. 2850 A

CONCRETE CONSTRUCTION.—TECHNICAL ENGINEER REQUIRED, experienced in the Calculation and Design of Ferro-concrete Structures of all classes. Progressive appointment to suitable man.—Address, giving full particulars of experience and salary required, 2846, The Engineer Office. 2846 A

ENGINEER FOR UNLOADING QUAY.—REQUIRED for Rouen, a thoroughly trained FRENCH MECHANICAL ENGINEER with a good knowledge of Electricity, to Take Charge of a Quay near Rouen, consisting of rotary converters and electrical transporters working grabs. Must have had previous control of men and management of a wharf and possess a knowledge of English. Salary not less than 1250 francs per month to commence. Reply in English, giving age, whether married, exact account of previous experience and qualifications.—Address, 2830, The Engineer Office. 2830 A

ENGINEER REPRESENTATIVE REQUIRED in London, East End area, by old-established firm, to work up outside connection. Must know the ground. Good money and prospects for right man. Full particulars in confidence.—Address, P7676, The Engineer Office. P7676 A

EXPERIENCED MECHANICAL ENGINEER. Knowledge Chemical Work preferred. Good prospects for capable representative man.—Address, P7652, The Engineer Office. P7652 A

POWER STATION SUPERINTENDENT WANTED for a large Power Station in healthy part of the East; 4 years' contract. Consideration will be given only to applications from men who have occupied responsible posts in similar capacity.—Address, with full details as to age, whether married or single, and full particulars of education and all subsequent experience, P7679, The Engineer Office. P7679 A

REQUIRED by English Firm of Engineers in India, an ASSISTANT MECHANICAL ENGINEER, capable of Preparing Estimates for Foundry, Blacksmiths', and Machine Shop Work. Applicants should have had practical experience in mechanical engineering workshops also in drawing-office and estimating department. Must be a bachelor, age 28 to 35.—Apply, giving full particulars of experience, to E.R. 910, c/o Deacon's, Leadenhall-street, E.C. 3. 2872 A

REQUIRED, Thoroughly Capable MAN as FOREMAN of large Spring-making Plant manufacturing springs for railway rolling stock, both laminated, coil, and volute types. Successful applicant must be a man of initiative, energy, and with sufficient experience to qualify him to take full control of the plant and men employed.—Address, giving full particulars of experience, salary required, &c., 2863, The Engineer Office. 2863 A

TWO INSPECTING and TESTING ENGINEERS WANTED.—Apply, giving experience, to HERON, ROGERS and PETTIT, 181, Queen Victoria-street, E.C. 4. P7649 A

WATERWORKS ENGINEER.—WANTED for Scotch undertaking with large scheme in progress, ASSISTANT, with good experience in the Design and Construction of Large Pipe Lines and Reinforced Concrete Work; 2 years' work; fixed salary £380. Send chronological statement of experience, state of health, age, and testimonials.—Address, 2834, The Engineer Office. 2834 A

WATER TURBINE ESTIMATES.—WANTED IMMEDIATELY, HYDRAULIC ENGINEER, experienced on this work.—Address, stating experience and salary required, 2824, The Engineer Office. 2824 A

WANTED for London Office, a Fully Qualified DRAUGHTSMAN, with general mechanical and structural experience in Steel Works Plant Design. Knowledge of application of electrical equipment a recommendation.—Replies requested from first-class reliable men only, and should state experience, age, and salary expected, to "STRUCTURE," c/o Tayler's, 30, Fleet-street, London, E.C. 2869 A

WANTED, SENIOR DRAUGHTSMAN, with First-class experience in the Design of Aero-engines and High-class Motor Cars.—Address, giving full particulars of experience and salary required, 2866, The Engineer Office. 2866 A

CONSTRUCTIONAL STEEL DRAUGHTSMAN.—WANTED in London, DRAUGHTSMAN for Design and Detail of Constructional Steel Work under the London Building Acts and the L.C.C. (General Powers) Act, 1909, for steel-framed buildings.—State age and salary.—P7638, The Engineer Office. P7638 A

DRAUGHTSMEN, Railway Carriage and Wagon.—Apply (letter only), stating age, experience, and salary, METROPOLITAN CARRIAGE CO., Saltley, Birmingham. 2802 A

DRAUGHTSMAN REQUIRED for Engineer's London Office, skilled in preparing lay-out drawings of Conveying Plant for coal, ore, &c. Only experienced men with designing experience need apply. State age, experience, and salary expected.—Address, 2882, The Engineer Office. 2882 A

DRAUGHTSMEN WANTED: Required for Steel Caissons, Dock Gates, and Heavy Opening Bridges. Only men who have actually been recently engaged upon the design and detail drawings of such work need apply.

Applications, stating age, salary required, and full particulars of training and experience and when at liberty, to STAFF MANAGER, Port of London Authority, Trinity-square, E.C. 3. 2775 A

DRAUGHTSMAN WANTED, Accustomed to Colliery Screening Plants, Headgears and Structures.—State experience, references, when at liberty, and salary to G. R. TURNER, Ltd., Langley Mill, Notts. 2860 A

DRAUGHTSMAN WANTED for East Coast; Must be first-class man, experienced in Design of Commercial Petrol Vehicles. State age, experience, and salary required.—Address, 2819, The Engineer Office. 2819 A

SITUATIONS OPEN (continued)

DRAUGHTSMAN WANTED for Manchester District, experienced in the Design of Important Civil Engineering Works. Salary £300 to £375, according to experience. State age and full particulars.—Address, 2844, The Engineer Office. 2844 A

ENGINEER DRAUGHTSMAN, Not Over 40 Years of age, for Dock Design. Must have had experience on Dock or Harbour Work and should be able to set out and measure up.—Address, stating age and salary required, 2862, The Engineer Office. 2862 A

HEATING and VENTILATING DRAUGHTSMAN REQUIRED by Firm of Heating and Ventilating Engineers in London; must be capable of preparing schemes, taking off quantities, &c.—Address, stating experience, age, and salary required, 2864, The Engineer Office. 2864 A

STRUCTURAL DRAUGHTSMAN WANTED for Works in South Wales; first-class detailer with technical training of Works Buildings and Crane Gantries; permanency and good salary to a reliable man; only men with first-class constructional experience need apply.—Address, 2877, The Engineer Office. 2877 A

THOROUGHLY RELIABLE and EXPERIENCED DRAUGHTSMAN REQUIRED for London office. One having Aerial Ropeway experience or similar knowledge an advantage. Must be quick and accurate worker. Good prospects for right man.—Address, giving age, experience, and salary required, 2875, The Engineer Office. 2875 A

CEYLON.—ENGINEER FOREMAN REQUIRED; must be capable of taking charge of jobbing shops fitted with modern machinery and had practical experience in Turning, Milling, &c. Age about 30 and single.—Write, giving particulars of apprenticeship and experience since, Box H759, Lee and Nightingale, Advt. Offices, Liverpool. 2849 A

MACHINE SHOP FOREMAN, Who Can Produce efficiently great variety of small interchangeable parts on turrets, presses, &c., WANTED by Switchgear Manufacturers in Midlands.—Write, stating age, wage, and full experience, Box 101, Sells Advertising Offices, Fleet-street, E.C. 4. 2850 A

WANTED, a MAN to Take Charge of an Up-to-date Steel Sleeper Plant. Must be able to make his own templates and tools, &c.—Address, stating age, experience, and wages required, 2823, The Engineer Office. 2823 A

SITUATIONS WANTED

WANTED by Gentleman who has Represented a leading Sheffield house for some years, a POSITION as REPRESENTATIVE in London and Eastern and South-Eastern Counties. Exceptional personal connection amongst engineers and allied trades. Excellent references. Commission and expenses only.—Address, 2825, The Engineer Office. 2825 B

ADVERTISER (29) SEEKS POSITION, Buyer or Assistant Engineers' Supplies, Ironmongery, &c.—Address, S. WOODWARD, 14, Seymour-road, Hampton Wick, Mdx. P7678 B

A.M.I.C.E., A.M.I. Mech. E., Aged 33, DESIRES more SCOPE. Any branch of engineering; thorough knowledge of foundry work and general engineering.—Address, P7677, The Engineer Office. P7677 B

ENGINEER (33), Late Fitt. and Erect. Shop Supt., Works, and radial aero-engines, DESIRES lesser POST if permanent or as Instructor. Exp. and charge of foundry, hardening, turning and tool depts.; pract. and tech., good organiser, moderate salary, any district or abroad.—Address, P7675, The Engineer Office. P7675 B

ENGINEER, Late Manager Small London Works, with 30 years' experience of general engineering, SEEKS responsible POST in works or office. Excellent testimonials.—SNOAD, 36, York-road, Hitchin. P7674 B

ENGINEER (Pract. and Tech.), 20 Years Foreman and manager, SEEKS similar POST; loco., refrigerator, electrical and works maintenance experience.—Address, P7673, The Engineer Office. P7673 B

ELECTRICAL ENGINEER (Polytechnikum of Zurich), 23, British subject, fluent English, French, German, some workshop experience, SEEKS APPOINTMENT; moderate initial salary. MALEORN WORINGER, 3, Apollostrasse, Zurich 7. P7667 B

MECHANICAL ELECTRICAL ENGINEER, Having completed contract with consulting engineers, DESIRES RE-ENGAGEMENT, home or abroad. College and university training, premium apprenticeship, large experience in engineering works methods, power station design and construction, sub-stations, transmission lines, compressed air, colliery work, special engineering experience during the war, accustomed to handle men. Would accept Junior Partnership in well-established engineering or consulting business.—Address, P7624, The Engineer Office. P7624 B

MECHANICAL ENGINEER, 14 Years' Varied Experience, steam and machine tools, practical and design, DESIRES to NEGOTIATE for PROGRESSIVE POST of RESPONSIBILITY, preferably as Works Manager or Assistant Works Manager. Thoroughly conversant with modern methods of production and organisation, 34 years of age. At present occupying important technical position with large firm of engineers of first-class repute. London district or South of England preferred.—Address, P7654, The Engineer Office. P7654 B

PRACTICAL PRINTER DESIRES POST in Publicity Department as SUPERVISOR of Printing, &c. Technical knowledge of catalogues and commercial printing.—E. H., c/o 86, Sir Thomas White's-road, Coventry. P7665 B

SALES MANAGER DESIRES APPOINTMENT. Has had long and varied experience in sales organisation at home and in many countries abroad; has specialised in overseas trade; thoroughly understands advertising, publicity and catalogue work, and has been three years manager of a limited company of which he was made a director. He is a mechanical engineer, public school man, knows London and export work, age 36, speaks fluent French and German, has tact and organising ability, and can handle large staff.—Address, P7666, The Engineer Office. P7666 B

STEEL FOUNDRY MANAGER or WORKS MANAGER DESIRES ENGAGEMENT; 25 years' experience as steel foundry manager, possessing a wide knowledge of steel castings from a few pounds up to 25 tons.

Thoroughly capable of taking full charge of all departments and possessing a wide knowledge of piecework and up-to-date foundry practice.

Full particulars of records and references.

Address, P7662, The Engineer Office. P7662 B

STRUCTURAL ENGINEER (33), in London, DESIRES responsible POSITION; 23 years' experience designing, estimating, detailing, correspondence, commercial, buying, &c., including control and organisation.—Address, P7680, The Engineer Office. P7680 B

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For continuation of Small Advertisements see page 3

Spiral Bevel Gears.

By W. C., D.

No. II.*

Finishing Cutter Settings.—Fig. 7 illustrates how the finishing cutter settings are determined graphically. Here O A is the pitch cone distance and A B represents the face width of the gear or pinion. At the centre of the face point E a line is drawn at an angle θ representing the pitch line spiral angle already chosen, and another line at right angles to the spiral angle is drawn through the point E projecting to the point D, the distance of which is equal to the radius from the centre of the cutter to the centre of the cutter blades, viz., 6in. Point D therefore represents the centre of the cutter as used for the roughing operation, X being the horizontal setting and Y the vertical setting. Since, however, the blank is set in towards the cutter so that the cutter blades cut along the root line of both sides of the teeth, the distance from the pitch line of the gear to the centre of the cutter will be less than 6in. from the inner edge of the cutter when generating the bottom side of the teeth and greater than 6in. from the outer edges of the cutter to the centre when generating the top side of the teeth.

In distinguishing the top and bottom sides of the teeth the pinion and gear should be considered as mounted in the machine for cutting and that side of the blank be viewed on which the cutter is working.

The distance from the centre of the cutter to the inner edge of the cutter blades at the pitch line is equal to the inner radius of the cutter, which is 6in. minus one-half the point width plus the tangent of the effective pressure angle multiplied by the product of the flank depth at the centre of the face of the gear or pinion.

The flank depth is the depth of the teeth from the pitch line to the root of the teeth, and in cases where it differs for the gear and pinion, as in the case of long and short addendum teeth, there will be one set of distances for the pinion and another for the gear.

Since the proportions of the teeth are proportional to the distance from the pitch cone centre O, the flank depth at the centre of the face will be equal to the flank depth at the large end of the teeth multiplied by the product of the cone distance minus one-half the face width divided by the cone distance.

When determining these cutter distances it should be noted that the effective pressure angles are not the same for both sides of the teeth, and that the outer radius of the cutter is 6in. plus .030 = 6.030in., and the inner radius is 6in. less .030 = 5.970in.

The cutter distances are now obtained as follows :—

Pinion top side = outer cutter radius + flank depth at centre of face × tangent effective pressure angle top side of teeth.

Pinion bottom side = inner cutter radius − flank depth at centre of face × tangent effective pressure angle bottom side of teeth.

Gear top side = inner cutter radius − flank depth at centre of face × tangent effective pressure angle top side of teeth.

Gear bottom side = outer cutter radius + flank depth at centre of face × tangent effective pressure angle bottom side of teeth.

As already explained, the cutter travels in a circular path along the root line of the teeth ; therefore to obtain the primary cutter settings it is necessary to take into consideration the root line spiral angle. The inner cutter blades produce a root line spiral angle which is less than the pitch line spiral angle and the outer cutter blades produce a larger spiral angle at the root than at the pitch line.

The correction angle to be applied to the pitch line spiral angle to give the root line spiral angle for both top and bottom sides of the teeth of gear and pinion is determined as follows :—

Correction angle = block angle gear or pinion (in minutes) × tangent effective pressure angle × cosine pitch line spiral angle.

This correction is applied to the pitch line spiral angle in the following manner :—

Pinion top side = pitch line spiral angle plus correction angle.

Pinion bottom side = pitch line spiral angle minus correction angle.

Gear top side = pitch line spiral angle minus correction angle.

Gear bottom side = pitch line spiral angle plus correction angle.

The primary vertical and horizontal settings are found in a similar manner as the roughing cutter settings, but using the cutter distances and root line spiral angles as determined above.

The primary vertical setting = distance to centre of cutter × cosine root line spiral angle.

The primary horizontal setting = cone distance minus one-half face width minus distance to centre of cutter multiplied by cosine root line spiral angle.

Since the cutter distances and root line spiral angles are all different for both top and bottom sides of the teeth of the gear and pinion, there will be primary vertical and horizontal settings for the top side of the pinion teeth and another set for the bottom side of the pinion teeth, and there will be a corresponding set of settings for both top and bottom sides of the gear teeth.

Referring to Fig. 7, which shows the finishing cutter settings for a right-hand spiral, E M_1 is the cutter distance of the inner cutter blades which generate the bottom side of the teeth and angle P_b is the root line spiral angle for the bottom side of the teeth, E M_2 is the cutter distance for the outer cutter blades which generate the top side of the teeth, and angle P_t is the root line spiral of the top side of the teeth.

X and Y are the horizontal and vertical settings for the roughing cutter, X_1 and Z_1 are the primary horizontal and vertical settings for the finishing cutter to generate the bottom sides of the teeth, while X_2 and Z_2 are the primary horizontal and vertical settings for the finishing cutter to generate the top side of the teeth.

When the teeth are being generated, however, the blank is rotated about centre O by an amount which is dependent upon the pitch of the teeth ; also the cutter centre oscillates about the centre O, therefore the primary horizontal setting can be transferred to the same horizontal setting as used for roughing by swinging points M_1 and M_2 about the centre O until they strike the vertical line at N_1 and N_2 respectively, denoting the horizontal setting for roughing. When this has been done it is necessary, however, to calculate the new vertical distances for N_1 and N_2, and since the hypotenuse of the two triangles M_1 O P and N_1 O D are equal, and since the triangles M_2 O R and N_2 O D are equal and the horizontal distance O D, already known, is constant for both cases, we have the following simple proportions :—

$$Y_1 = \sqrt{Z_1^2 + X_1^2 - X^2}$$

$$Y_2 = \sqrt{Z_2^2 + X_2^2 - X^2}$$

Y_1 and Y_2 are now the required vertical settings for the finishing cutter and are calculated for both gear and pinion, which should be specified to the gear cutter in the following order :—

Right-hand Spiral Pinion and Left-hand Gear.

	Pinion up.	Out.	Gear down.
Top side teeth	Y_2	X	Y_1
Bottom side teeth	Y_1	X	Y_2

Left-hand Spiral Pinion and Right-hand Gear.

	Pinion up.	Out.	Gear down.
Top side teeth	Y_1	X	Y_2
Bottom side teeth	Y_2	X	Y_1

In addition to the above information to be given to the gear-cutting department, it is necessary to specify the corrected pitch depth and corrected normal chordal thickness. Although the author can show how these dimensions can be arrived at mathematically, the calculations entailed are considerable ; therefore the lay-out method is recommended, as it is sufficiently accurate for all practical purposes, as the dimensions can be got to within one-thousandth part of an inch if the lay-out is made, say, two or three times the actual size.

The lay-out method is shown in Fig. 8, in which a developed face of the gear or pinion is drawn, O A being the cone distance and A B the face width. At E, midway between A and B, draw a line through E at an angle equal to 90 deg. minus the spiral angle and passing to point D, the distance E D being equal to the mean radius of the cutter, viz., 6in. From centre D with E D as radius draw arc S T. It will be noted that D represents the settings for the roughing cutter which have already been calculated, therefore point D will be more accurately located if the calculated dimensions are used instead of scaling the angle D E P. From point S mark off S *b* equal to half the circular thickness. Draw *b* D intersecting S T at *c* and draw line O *c*. The corrected thickness and depth are measured normal to the tooth along line *b c*, and since the proportions of the teeth at any point along the face width are proportional to the distance from the cone centre, then—

Normal chordal thickness of the tooth in the normal section at $b\,c = \frac{O\,c}{O\,A} \times$ (chordal thickness in diametral plane × sine angle D *c* O).

Corrected pitch depth of the tooth in the normal section at $b\,c = \frac{O\,c}{O\,A} \times$ corrected pitch depth in diametral plane.

In the case of long and short addendum teeth there will be one set of values for the pinion and another for the gear.

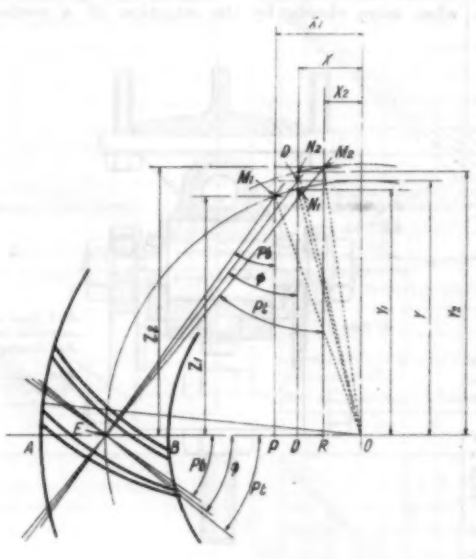

Fig 7. Showing Machine Settings for Finishing Cutter for Right-Hand Spiral.

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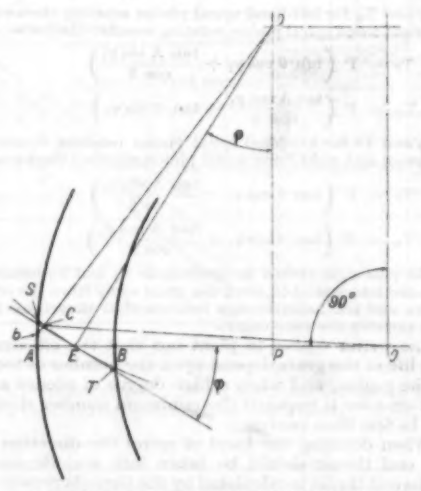


Fig 8. Showing Layout Method of Obtaining Normal Chordal Thickness & Corrected Pitch Depth of Spiral Bevel Gears.

Simon Sc.

Conclusion.

The foregoing remarks have dealt with the various points in connection with the design of these gears, and for reference purposes the formulas are summarised in the following tables :—

Notation Used in the Design of Spiral Bevel Gears.

Design.	Gear.	Pinion.
Diametral pitch	p	p
Circular pitch	p_1	p_1
Number of teeth	N	n
Pitch diameter	D	d
Cone distance	C	C
Working depth	W	W
Addendum	S	S_1
Dedendum	u	u_1
Clearance	f	f
Full depth of tooth	U	U
Pitch cone angle	φ	φ_1
Angle increment	δ	δ_1
Face angle	a	a_1
Block angle	γ	γ_1
Root angle	β	β_1
Diameter increment	b	b_1
Outside diameter	D_1	d_1
Circular thickness of tooth on outer pitch circumference	T	t
Chordal thickness on outer pitch circumference	T_c	t_c
Spiral angle	θ	θ
Lead	L	L
Face width	F	F
Normal chordal thickness of tooth in normal section	x	x_1
Corrected pitch depth in normal section	y	y_1
Back cone radius	R	r
Angle subtended by tooth thickness on the back cone pitch radius	ψ	ψ_1
Axial thrust	T_G	T_P

Formulas for Spiral Bevel Gears.

The following is a summary of formulas used in connection with the design of the Gleason type spiral bevel gears :

$$D = \frac{N}{p} \qquad d = \frac{n}{p}$$

$$p_1 = \frac{\pi}{p}$$

$$C = \frac{D}{2 \times \sin \varphi}$$

$$W = \frac{2}{p} \times .85$$

* No. I. appeared June 22nd.

$$S = \frac{2}{p} \times .255 \qquad S_1 = \frac{2}{p} \times .595$$

$$U = \frac{2}{p} \times .595 \qquad U_1 = \frac{2}{p} \times .255$$

$$f = .07\, p_1$$

$$\varphi = \tan \frac{n}{N} \qquad \varphi_1 = 90 - \varphi$$

$$\delta = \tan \frac{S}{C} \qquad \delta_1 = \frac{S_1}{C}$$

$$a = \varphi + \delta \qquad a_1 = \varphi_1 + \delta_1$$

$$\gamma = \tan \frac{u}{C} \qquad \gamma_1 = \tan \frac{u_1}{C}$$

$$\beta = \varphi - \gamma \qquad \beta_1 = \varphi_1 - \gamma_1$$

$$b = S \times 2 \times \cos \varphi \qquad b_1 = S_1 \times 2 \cos \varphi_1$$

$$D_1 = D + b \qquad d_1 = d + b_1$$

$$T = \frac{\pi}{2p} - \left\{2 \tan 14\tfrac{1}{2}^\circ \times \left(\frac{W}{2} - S\right)\right\} \qquad t = \frac{\pi}{2p} + \left\{2 \tan 14\tfrac{1}{2}^\circ \times \left(\frac{W}{2} - S_1\right)\right\}$$

$$R = \frac{D}{2 \sin (90 - \varphi)} \qquad r = \frac{d}{2 \sin \varphi}$$

$$\psi = \frac{360}{\left(\frac{\pi 2 \times R}{T}\right)} \qquad \psi_1 = \frac{360}{\left(\frac{\pi 2 \times r}{t}\right)}$$

$$T_e = 2 \sin \tfrac{1}{2} \psi \times R \qquad t_e = 2 \sin \tfrac{1}{2} \psi_1 \times r$$

$$\text{sine } \theta = \frac{\text{Cutter constant}}{\text{Angles } \gamma + \gamma_1 \text{ (in min.)}}$$

$$L = F \times \text{tan spiral angle } \theta$$

$$x = \frac{O\,c}{O\,A} \times T_e \qquad x_1 = \frac{O\,c_1}{O\,A_1}\, t_e$$

T_P and T_G for left-hand spiral pinion rotating clockwise and right-hand spiral pinion rotating counter-clockwise :—

$$+ T_P = P \left(\tan \theta \cos \varphi_1 + \frac{\tan A \sin \varphi_1}{\cos \theta}\right)$$

$$+ T_G = P \left(\frac{\tan A \cos \varphi_1}{\cos \theta} - \tan \theta \sin \varphi_1\right)$$

T_P and T_G for left-hand spiral pinion rotating counter-clockwise and right-hand spiral pinion rotating clockwise :

$$- T_P = P \left(\tan \theta \cos \varphi_1 - \frac{\tan A \sin \varphi_1}{\cos \theta}\right)$$

$$+ T_G = P \left(\tan \theta \sin \varphi_1 + \frac{\tan A \cos \varphi_1}{\cos \theta}\right)$$

The plus signs shown as prefixes to T_P and T_G indicate that the forces tend to force the gears away from the cone centre and the negative sign indicate that they force the gear towards the cone centre.

The writer wishes to point out that the efficiency and life of the gears depend upon the number of teeth in the pinion, and when a high degree of silence and performance is required the minimum number should not be less than twelve.

When deciding the hand of spiral the direction of the end thrust should be taken into consideration. If the end thrust is calculated by the formula presented in the foregoing article, it will be found that in the case of a pair of gears with a right-hand spiral driving clockwise the axial thrust will be less than any other condition of spiral bevels; but this advantage is offset by difficulties which may arise from the fact that a right-hand spiral pinion driving clockwise tends to thread itself into the gear, while a left-hand spiral pinion rotating clockwise tends to force itself out of mesh with the gear. The latter condition can be met by providing a suitable thrust bearing, whereas if there should be any end play the threading-in action of a right-hand spiral pinion rotating clockwise would take up the clearance and would act as a wedge, which would, under a heavy load, probably shear the teeth. On the other hand, however, slight end play would not be detrimental in the case of a left-hand spiral pinion rotating clockwise, as the pinion would simply back away from the gear, which would only introduce additional backlash between the teeth, a condition which would not prevent the gears from working. From these remarks it will be clear that the hand of spiral should be such that the member having the greater axial thrust tending to force itself out of mesh, and since the rear axle of an automobile is running forward practically all the time when in use, a left-hand spiral pinion is recommended when the pinion is running clockwise when driving forward.

Boundary Lubrication in Engineering Practice.*

By T. E. STANTON.

IN a previous report to the Lubrication Research Committee of the Department of Scientific and Industrial Research, which was made in June, 1922, a description was given of a series of experiments on the lubrication of cylindrical surfaces in continuous relative motion, in which an attempt was made by means of reducing the arc of contact and increasing the intensity of normal pressure between the surfaces, to approximate to the conditions obtaining in the case of worm gears. Previous reports from the National Physical Laboratory to the Lubricants Inquiry Committee of the Department of Scientific and Industrial Research had afforded strong evidence of the existence of boundary lubrication in these gears, and it was hoped to develop a method by means of which the characteristics of boundary lubrication as it obtains in engineering practice could be conveniently studied.

The results of these experiments, however, indicated clearly that although a state of steady lubrication could be maintained between cylindrical surfaces with arcs of contact as small as 14 deg. and at intensities of pressure up to 3.5 tons per square inch, the surfaces were completely separated by a film of lubricant in which the distribution of pressure followed closely the theoretical distribution predicted from the hydro-dynamical theory. It was evident, therefore, that no resemblance existed between the state of lubrication thus brought into operation with those existing in worm gears in which the lubrication is known from the National Physical Laboratory experiments of 1921 to depend on characteristics of the lubricant other than its viscosity and on the nature of the two surfaces.

This dissimilarity of action was not extraordinarily remarkable, since the relative motion of the surfaces in the two cases, in all other respects than those mentioned above, was widely different, and it appeared evident that the existence of boundary lubrication depended upon factors other than those of pressure and arc of contact.

After some consideration, an attempt was made to imitate the conditions existing in worm gears somewhat more closely by the adoption of a method whereby, while preserving fairly high intensities of pressure and small arcs of contact, the relative motion of the surfaces, instead of having a steady value, was made oscillatory in character, and had a mean value of zero. This method was suggested by the results of Sommerfeld's analysis of the hydro-dynamical problem of the maintenance of a film of lubricant between the surfaces of a journal and a half bearing, which indicated clearly that contact of the surfaces would take place, *i.e.*, the film would break down, when the value of the relative velocity fell to zero.

The required condition was effected by the use of a pair of cylindrical lubricated surfaces in the form of a rocking shaft and its bearing, the oscillatory motion being produced by the attachment to the shaft of a heavy pendulum swinging under gravity. From observations on the rate of damping of this system, it was thought that the magnitude and characteristics of the frictional forces at the lubricated surfaces could be determined, provided that a steady supply of lubricant could be delivered to the sliding surfaces.

DESCRIPTION OF THE APPARATUS.

The arrangement of the apparatus is shown in Fig. 1. The experimental bearing, which is 3in. long by 1.7in. in diameter, is contained in a cast iron housing suspended from a bracket bolted to the cross girder supporting the roof of the workshop by means of a pin joint, which will allow freedom of adjustment in a direction at right angles to the plane of the swing. By this means the pressure between the surfaces will be symmetrical on either side of the plane of oscillation.

The total arc of contact of the journal and bearing is restricted to an arc of 45 deg. on either side of the vertical by cutting away the metal of the bearing in the region outside this arc, as shown. In order to approximate to the condition obtaining in worm gears that any two elements of surface in contact shall each be covered with fresh lubricant before the next contact, a series of special grooves was cut on the 90 deg. arc of the bearing which supported the load. By allowing the lubricant free access to those grooves, a copious supply to the actual bearing surfaces was ensured. A precisely similar series of grooves, intersecting these at right angles, was cut on the surface of the journal. To obtain this condition, the spirals were made right-handed for the bearing and left-handed for the journal, and had a pitch of π times the diameter. By this means the total area of contact of the surfaces was reduced to 0.25 square inches. In considering the attachment of the pendulum rod to the journal, it was thought advisable to provide means whereby the damping of the pendulum due to air friction alone could be studied, and for this purpose a locking device has been adopted by means of which the rocking shaft can be fixed either to the pendulum rod or to the bearing. In the latter case, the pendulum can oscillate on ball bearings fitted to the extension of the shaft on either side of the journal, as shown in Fig. 1. These ball bearings are housed on flitch plates on either side and lugs fixed to the rocking shaft are provided, so that they can be coupled to either the flitch plates or the bearing casting. The lubricant is supplied by a sight-feed lubricator to a chamber in the base of the bearing casting, from which the oil is conveyed by the passages shown to the various spiral grooves cut in the bearing. In order to maintain a copious supply of oil to the surfaces, end covers are also fitted to the bearing casting, in the manner shown in Fig. 1. By this means, oil-bath conditions are obtained over the 90 deg. arc of contact of journal and bearing.

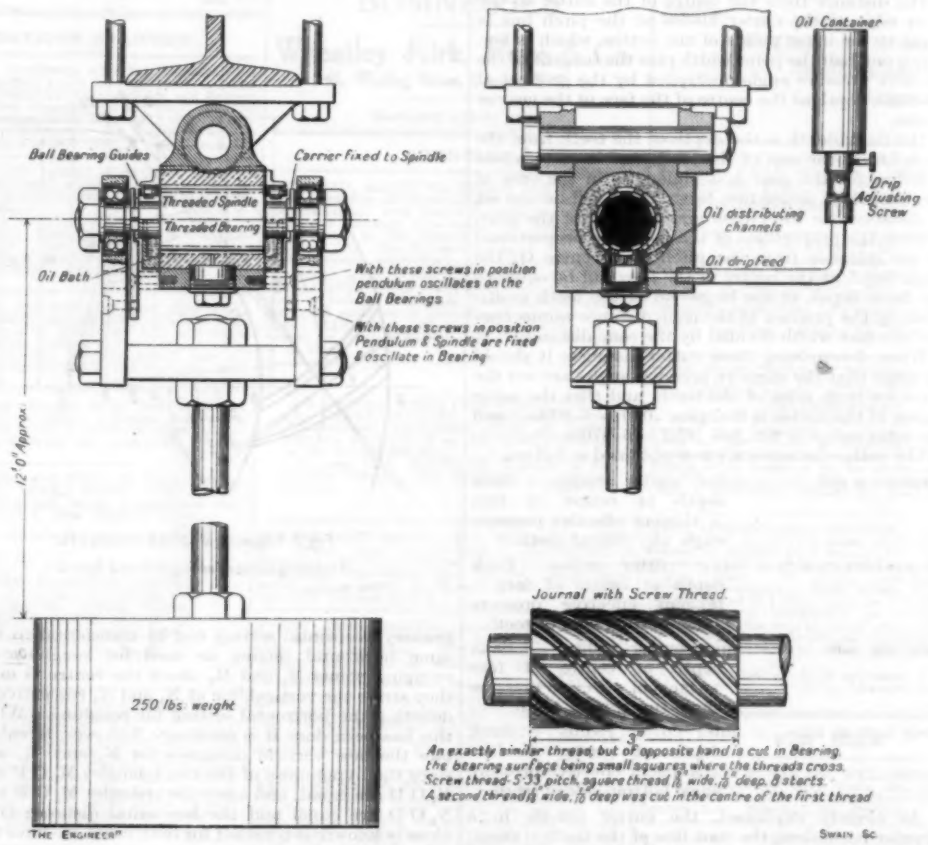

Oil Container
Ball Bearing Guides
Carrier Fixed to Spindle
Threaded Spindle
Threaded Bearing
Oil Bath
Drip Adjusting Screw
Oil distributing channels
Oil dripFeed
With these screws in position pendulum oscillates on the Ball Bearings
With these screws in position Pendulum & Spindle are Fixed & oscillate in Bearing
12'0" Approx.
250 lbs. weight
Journal with Screw Thread.
3"
An exactly similar thread, but of opposite hand is cut in Bearing, the bearing surface being small squares where the threads cross. Screw thread- 5·33 pitch, square thread 1/16 wide, 1/16 deep, 8 starts. A second thread 1/16 wide, 1/16 deep was cut in the centre of the first thread
"THE ENGINEER"
SWAIN &c

FIG. 1—ARRANGEMENT OF EXPERIMENTAL APPARATUS

THE MOTION OF THE PENDULUM.

From the above description, it will be seen that the free oscillations of the pendulum about its mean position will be subjected to damping forces, due to the friction of the shaft in the bearing and the resistance of the air to the motion of the pendulum.

Under these conditions, and provided that the amplitude of the oscillations is small, the motion of the pendulum is given by—

$$I\ddot{\theta} + W L \theta + M_2 \pm M_1 = 0,$$

Where M_1 is the moment of the friction about the axis, its sign depending upon the direction of the motion.

M_2 is the moment of the air resistance about the axis.

I is the moment of inertia of the pendulum about the axis.

L is the distance of the C.G. of the pendulum from the axis.

W is the weight of the pendulum.

* A report to the Lubrication Research Committee of the Department of Scientific and Industrial Research.

The solution of this equation is complicated by lack of knowledge of the amount of the air resistance of the pendulum and its law of variation with speed, but in the case of the present experiments, it has been found comparatively easy to use pendulums of such a weight that the actual value of the moment of the air resistance of the pendulum is negligible compared with the value of the moment of the bearing friction. Under these conditions, the motion of the pendulum is given by—

$$I\ddot{\theta} + WL\theta \pm M_1 = 0 \quad . \quad . \quad (2)$$

If we assume that the friction between the lubricated surfaces follows the laws of boundary lubrication investigated by Mr. W. B. Hardy, *i.e.*, its value is independent of the relative speed of the surfaces, then calling its value F, the solution of (2) is—

$$\theta = \mp \frac{F\,r}{WL} + A\cos\sqrt{\frac{WL}{I}}\,t$$

where r is the radius of the bearing and A is a constant depending on the initial conditions. Assuming that the motion begins when the pendulum is inclined at an angle a to the left of the vertical, then—

$$A = -a \pm \frac{F\,r}{WL}$$

and the maximum amplitude of the motion to the right at the end of the first half swing is—

$$a - \frac{2\,F\,r}{WL}$$

The successive amplitudes of the motion to the right will be—

$$a - \frac{6\,F\,r}{WL}$$

$$a - \frac{10\,F\,r}{WL}$$

$$a - \frac{14\,F\,r}{WL}$$

i.e., the damping of the oscillation will proceed at a uniform rate of $\frac{4\,F\,r}{WL}$ radians per complete oscillation.

Further, since the time of oscillation of the pendulum is independent of the amplitude of the swings and the friction, it follows that if the successive amplitudes of vibration of the pendulum be plotted on a time base, the criterion of the existence of boundary lubrication will be the possibility of drawing a straight line through the extremities of the successive ordinates representing the amplitudes.

RESULTS OF THE EXPERIMENTS.

Preliminary: Determination of the Approximate Value of the Air Resistance of the Pendulum.—For this purpose the journal was locked to the bearing and a set of observations was made on the damping of the oscillations of the pendulum when swinging on the ball bearing of the flitch plates—Fig. 1.

It was found that when the pendulum was swinging through a total arc of 5 deg., the rate of damping due to the combined action of the air resistance of the pendulum and the rolling friction of the ball bearings of the supports was .000023 radians per complete swing, which is equivalent to a force of 0.23 lb. at the rubbing surfaces. Of this, it is considered from the known coefficient of friction of ball bearings, that the bearings themselves would contribute not less than 0.1 lb. It is clear, therefore, that, compared with the frictional resistance of the rubbing surfaces in the present experiments, which was in no case less than 23 lb., the effect of the air resistance on the damping can be neglected.

Series I.: Hard Steel Journal, Grooved; Phosphor Bronze Bearing, Grooved.

(*a*) Lubricant, castor oil; absolute viscosity at 20 deg. Cent. = 7.5.

The observed amplitudes of successive swings under loads of 500 lb. and 250 lb.—2000 lb. and 1000 lb. per square inch of surface of bearing—plotted on a time base are shown in Figs. 2 and 3.

It will be seen that with the exception of the last two or three observations before the pendulum came to rest, the whole of the plotted points lie on a straight line for each test, indicating that the friction is independent of the relative speed of the surfaces between amplitudes of swing of 8 deg. to 0.5 deg.

Further, the slope of the lines for the two pressures of 2000 lb. and 1000 lb. per square inch are identical, showing that the friction is accurately proportional to the load. Inserting the values of $r = 0.85$in. and $L = 136$in. in the relation—

$$\frac{4\,F\,r}{WL} = \text{decay of oscillations per swing} = .0023 \text{ radians},$$

we have $\frac{F}{W}$ = coefficient of friction = .092.

From the fact that in these experiments the frictional resistance of the bearing followed Amonton's Law in being proportional to the load and independent of the relative speed of the surfaces over a considerable range of the motion, it would appear that the nature of the lubrication was that known as "boundary lubrication."

(*b*) Lubricant, a mineral oil of average quality, known as Bayonne; viscosity at 20 deg. Cent. = 1.6; loading conditions and surfaces as in (*a*).

In changing one oil to another, the journal and bearing were first well washed with petrol, then dried and washed again with methylated spirit. The surfaces were then dried in an air blast and covered with the new lubricant.

On testing the Bayonne oil, the results plotted in Figs. 2 and 3 were obtained.

It will be seen that the type of lubrication is the same as before, but that the coefficient of friction is considerably higher, and has a value of .128.

(*c*) The effect was then tried of adding small percentages of oleic acid to the Bayonne oil in order to find out whether any reduction of friction took place corresponding to that obtained in the worm gear tests previously carried out for the Lubricants and Lubrication Inquiry Committee. It was found that a 17 per cent. reduction in the coefficient of friction was obtained by the addition of as little as 1 per cent. of oleic acid to the Bayonne oil, and that increasing the amount up to 5 per cent. did not effect any improvement. The plotted results for Bayonne + 1 per cent. of oleic acid are shown in Figs. 2 and 3.

(*d*) Lubricant, a cylinder oil known as Shell-Mex Super Heavy, viscosity at 20 deg. = 9.7, was tried—see Figs. 2 and 3.

Lubrication of the same characteristics as before was obtained, with a coefficient of friction slightly greater than castor oil and equal to .10.

(*e*) A cylinder oil known as Shell-Mex Super Light; absolute viscosity at 20 deg. Cent. = 1.6; damping curves shown in Figs. 2 and 3; coefficient of friction = .108.

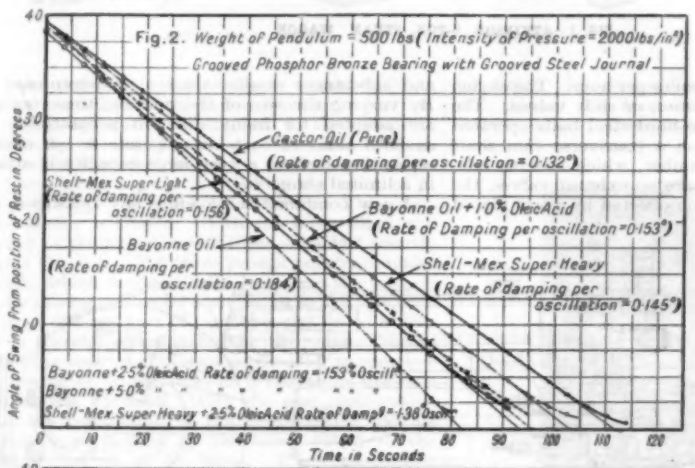


Fig. 2. Weight of Pendulum = 500 lbs (Intensity of Pressure = 2000 lbs/in²)
Grooved Phosphor Bronze Bearing with Grooved Steel Journal
Castor Oil (Pure)
(Rate of damping per oscillation = 0·132°)
Shell-Mex Super Light
(Rate of damping per oscillation = 0·156)
Bayonne Oil + 1·0% Oleic Acid
(Rate of Damping per oscillation = 0·153°)
Bayonne Oil
(Rate of damping per oscillation = 0·184)
Shell-Mex Super Heavy
(Rate of damping per oscillation = 0·145°)
Bayonne + 2·5% Oleic Acid Rate of damping = 153° Oscill°
Bayonne + 5·0% " " " " " " "
Shell-Mex Super Heavy + 2·5% Oleic Acid Rate of Damp° = 138 osc°
Angle of Swing from position of Rest in Degrees
Time in Seconds

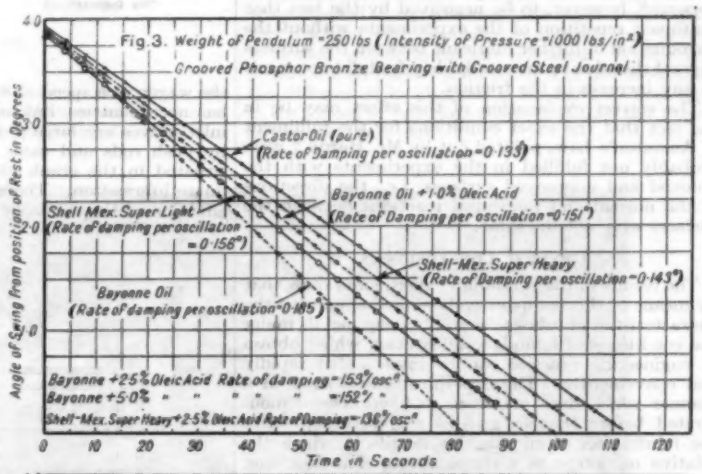


Fig. 3. Weight of Pendulum = 250 lbs (Intensity of Pressure = 1000 lbs/in²)
Grooved Phosphor Bronze Bearing with Grooved Steel Journal
Castor Oil (pure)
(Rate of Damping per oscillation = 0·135°)
Bayonne Oil + 1·0% Oleic Acid
(Rate of Damping per oscillation = 0·151°)
Shell Mex. Super Light
(Rate of damping per oscillation = 0·156°)
Shell-Mex. Super Heavy
(Rate of Damping per oscillation = 0·143°)
Bayonne Oil
(Rate of damping per oscillation = 0·185°)
Bayonne + 2·5% Oleic Acid Rate of damping = 153° osc°
Bayonne + 5·0% " " " " = 152° "
Shell-Mex. Super Heavy + 2·5% Oleic Acid Rate of Damping = 136° osc°
Angle of Swing from position of Rest in Degrees
Time in Seconds

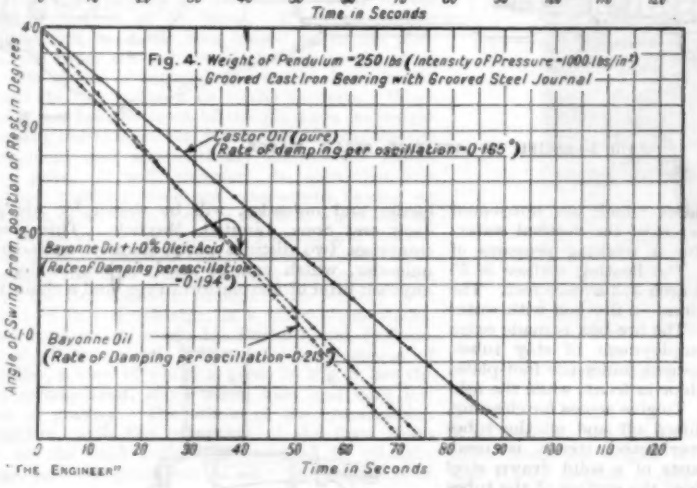


Fig. 4. Weight of Pendulum = 250 lbs (Intensity of Pressure = 1000 lbs/in²)
Grooved Cast Iron Bearing with Grooved Steel Journal
Castor Oil (pure)
(Rate of damping per oscillation = 0·165°)
Bayonne Oil + 1·0% Oleic Acid
(Rate of Damping per oscillation = 0·194°)
Bayonne Oil
(Rate of Damping per oscillation = 0·207°)
"THE ENGINEER"
Angle of Swing From position of Rest in Degrees
Time in Seconds

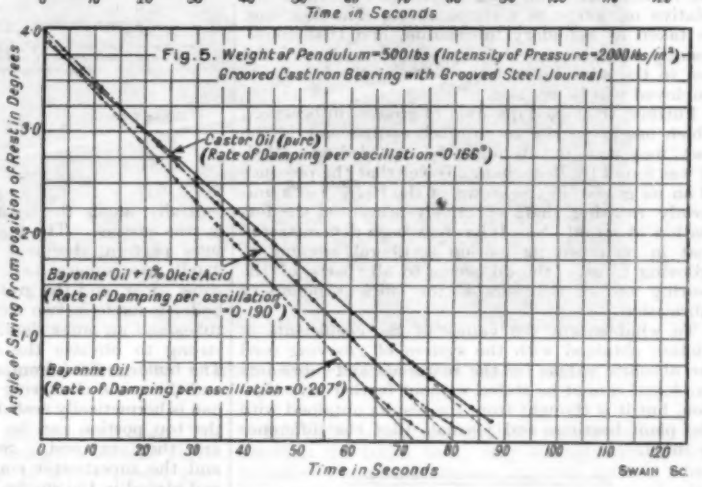


Fig. 5. Weight of Pendulum = 500 lbs (Intensity of Pressure = 2000 lbs/in²)
Grooved Cast Iron Bearing with Grooved Steel Journal
Castor Oil (pure)
(Rate of Damping per oscillation = 0·166°)
Bayonne Oil + 1% Oleic Acid
(Rate of Damping per oscillation = 0·190°)
Bayonne Oil
(Rate of Damping per oscillation = 0·207°)
Angle of Swing From position of Rest in Degrees
Time in Seconds
SWAIN Sc.

FIGS. 2 TO 5—CURVES SHOWING RATES OF DAMPING PER OSCILLATION

Series II.: Hard Steel Journal, Cast Iron Bearing, both Grooved as in Series I.—The damping curves with various lubricants and under loads of 250 lb. and 500 lb. are shown in Figs. 4 and 5.

The characteristics of the lubrication appear to be the same as in Series I. There is, however, some evidence in the case of the Bayonne oil and of the Bayonne oil + .1 per cent. of oleic acid of a slight departure from Amonton's Law, in that the friction of the lower load (250 lb.) is from 2 to 3 per cent. greater than that at the high load (500 lb.). As the intensities of pressure are somewhat high—2000 lb. per square inch—further experiments are being made with a larger area of surface.

The results of the tests on Series I. and II. are collected in the following table:—

Coefficients of Friction of Grooved Surfaces.

Lubricant.	Viscosity of lubricant at 20 deg. Cent.	Coefficient of friction.
Hard steel journal, phosphor bronze bearing—		
Castor oil	7.5	.092
Bayonne	1.6	.128
Bayonne + 1 per cent. oleic ..	1.6	.105
Bayonne + 2 per cent. oleic ..	1.6	.106
Bayonne + 5 per cent. oleic ..	1.6	.106
Shell-Mex heavy	9.7	.100
Shell-Mex light	1.6	.108
Hard steel journal, cast iron bearing—		
Castor	7.5	.115
Bayonne	1.6	.143

Series III.: Hard Steel Journal in a White Metal Bearing.—In these tests the bearings were made on a

commercial bearing metal of good average quality.

The first bearing was grooved similarly to the phosphor bronze and cast iron ones used in Series I. and II.

The results of the tests were, however, extremely erratic, probably owing to the fact that the intensity of pressure between the surfaces was too high, and it was found that the white metal wore away quickly. The tests were then repeated with a plain (ungrooved) journal and bearing of the same material.

Under these conditions, the results were more consistent, but it was found that the damping curve was concave to the time axis, indicating that the frictional resistance was increasing as the amplitude of the swings diminished. This effect is being investigated further.

Series IV.: The Effect of Modifications of the Grooving.—For this purpose a plain steel journal and a plain phosphor bronze bearing were used. When using castor oil as the lubricant, it was found that moderately steady conditions could be obtained, but that the friction was in all cases some 20 per cent. greater than that which existed between the grooved surfaces.

An explanation of this effect which immediately suggested itself was that the lubricant between the surfaces was gradually squeezed out during the course of the experiment, and owing to the absence of the grooves could not be replaced. This assumption appeared, however, to be negatived by the fact that continued repetition of the experiments without the introduction of further lubricant between the surfaces beyond that due to the steady drip feed did not result in any increase in the friction.

The correct explanation of this effect may lie in the fact that the exact conditions for the fulfilment of Amonton's Law, pointed out by Mr. Hardy,† were probably not fulfilled in the experiments with the grooved and ungrooved surfaces, *i.e.*, the directions of the normal and tangential reactions between the surfaces were not the same.

General Conclusions.

The results of the pendulum experiments show that by means of this comparatively simple apparatus the characteristics of lubricants and bearing metals under the conditions of boundary lubrication which obtain in engineering practice can be investigated rapidly and conveniently. The experiments also show in a manner which does not seem to have been demonstrated before that in general engineering practice the lubrication of all machine details in which the relative motion is of a reciprocating character may be taken as boundary lubrication, and that consequently in such cases the improvements in efficiency due to the addition of fatty acids to the lubricants employed will be realised.

Further, the vexed question of grooves in bearings, which has given rise to so much controversy in the past, may now, it is thought, be regarded as settled. It was found by Beauchamp Tower that the presence of an oil groove in the crown of the bearing of a uniformly rotating shaft effectively prevented the formation of an oil film. It has now been demonstrated that in reciprocating motion a liberal amount of grooving to give the oil access to all parts of the bearing surface is desirable for efficient boundary lubrication.

To what extent the values of the coefficients of friction obtained with the system of grooving used are absolute values for the materials and lubricants employed cannot be stated without further investigation, but it is thought from the results obtained with the plain bearings and journals that the difference is small.

† "Dictionary of Applied Physics," article "Lubrication," page 574

The Royal Show at Newcastle.

No I.

THE eighty-second annual show of the Royal Agricultural Society will be held next week at Newcastle-upon-Tyne. The last occasion that it was held in that city was in 1908, when the attendance of the public exceeded that at any previous Show; in fact, a record was set up which has not yet been eclipsed. Compared with the 1908 Show the entries of live stock, poultry and produce at this year's exhibition show a very considerable increase, thanks chiefly to the development which has taken place since the war in pig rearing. This profitable branch of farming is responsible for over one thousand entries, or three times as many as in 1908. The number of stands in the implement yard also shows a satisfactory increase, namely, 453, compared with 389 at the last Newcastle Show, though the space occupied is much about the same, namely, 11,902ft. run. The space devoted to machinery is somewhat less than was the case at Cambridge, and is considerably smaller than at either Derby or Darlington in 1921 and 1920 respectively. The cause for this is, no doubt, the prolonged period of depression through which the implement side of the engineering industry is now passing.

In the steam wagon section Messrs. Atkinson and Co., of Preston, are showing their 6-ton machine, the most interesting features of which, from an engineering point of view, are the engine and boiler. Views of wagon, engine and boiler are given in Figs. 1, 2 and 3. The engine is of the uniflow, horizontal, slow-speed type, having twin double-acting cylinders, 6¼in. diameter by 10in. stroke. When making 200 revolutions per minute, this engine is geared to propel

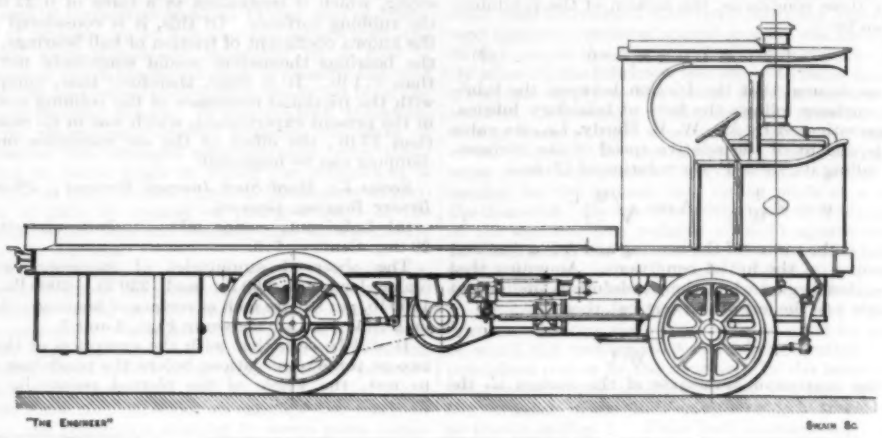


FIG. 1—ATKINSON 6-TON STEAM WAGON

the wagon at a speed of 8 miles per hour. The engine has no excentrics, link motion or slide valves. The inlet valves are large glass-hard steel balls operated by push rods and cams on a transverse cam shaft situated in the crank chamber, which ensures adequate lubrication. There are no exhaust valves, the eduction of the steam being effected by ports placed

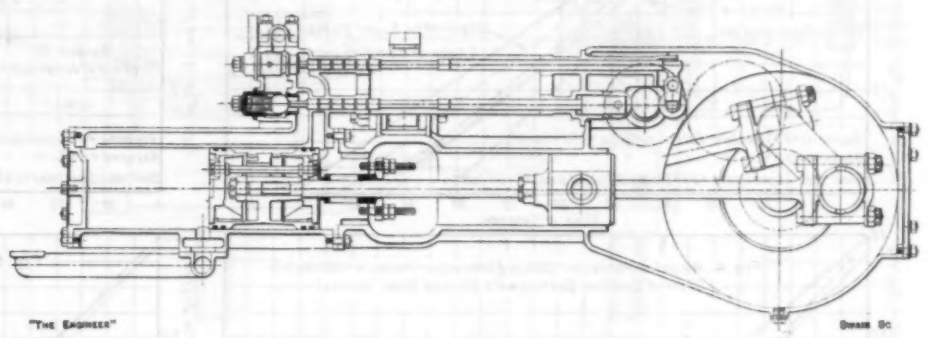


FIG. 2—ENGINE OF ATKINSON STEAM WAGON

centrally along the cylinders which are uncovered by the pistons. The boiler is of the vertical water-tube pattern, designed for a working pressure of 230 lb. per square inch. The heating surface is 55 square feet, and the grate area 3.3 square feet. The boiler is made in two sections—a fire-box with water tubes and an outer shell. The fire-box is made extra strong to obviate the employment of stay tubes. The boiler is fired from a shoot under the foot-plate, and there is a clinkering door in front, while the ash-pan is hermetically sealed. To give access for cleaning, the top portion can be lifted off and all the tubes are then exposed. Superheated steam is used, and the superheater consists of a solid drawn steel coil placed in the smoke-box, the surface of the tubes being calculated to superheat the steam about 150 deg. Fah. A feed-water heater is also one of the features of the Atkinson wagon. The front axle is of high-resistance steel, and on it are formed eyes, which are bronzed bushed, and which support the pivots of the front wheels. The pivots and journals are steel forgings. The front wheels are turned in their pivots by means of a screw and lever gear operated by a teak-lagged hand wheel, 16in. diameter. The screw works in an oil bath, and both screw and nut are protected by a dust-proof case. The rear axle, which is of chrome-nickel steel, is strong and light. The journals are automatically lubricated, and the axle-boxes are easily accessible for filling. The transmission gear consists of a steel sprocket pinion on the crank shaft, and a heavy chain, running on to the rear axle sprocket wheel, which contains the differential gear pinions. The usual countershaft and change-speed gears are dispensed with. The thrust from the rear axle to the frame is taken by steel radius rods and nuts, which are provided with a locking device. The differential gear wheels are of cast and forged steel, and all the parts are enclosed in an oil-tight case. Three independent brakes are provided. One, which is operated by foot, acts on drums bolted to the back wheels; another, which is worked by hand, is connected to a friction strap on the back axle. Reversing the engine provides the third means of braking.

The most novel exhibit on the stand of R. Boby, Limited, of Bury St. Edmunds, will be the Carter disc separator which operates on a new principle, which effects very fine separations of grain with facility and precision, while the space occupied is extremely small. As its name implies, this separator is composed of a number of cast iron discs mounted at intervals on a horizontal spindle—Fig. 4—the discs rotating through the grain. On both sides of each disc are some thousands of pocket-shaped recesses, which lift out from the grain particles and substances smaller than a predetermined size. By varying the size of the pockets, these machines are adapted for many different separations, and, as both sides of each disc operate as an effective separating surface, a very large capacity is attained in a limited compass.

A new combined self-loading hay rick-lifter, with loader and unloader, will be shown by Alexander Jack and Sons, Limited, Maybole. This machine comprises two distinct parts, namely, a loader and unloader, which can be used in conjunction with any rick-lifter of the platform type, and a chain trans-

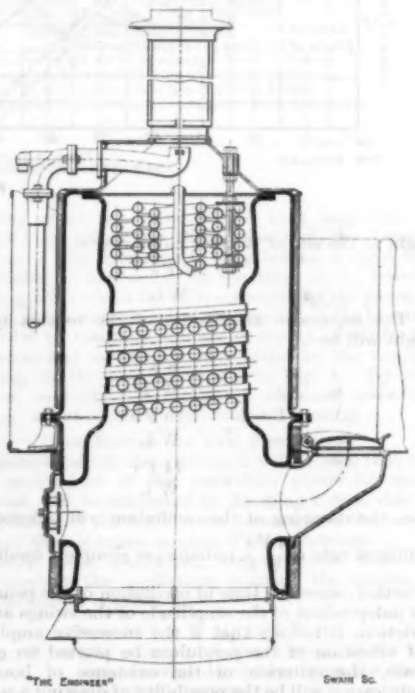


FIG. 3—ATKINSON STEAM WAGON BOILER

mission from the near travelling wheel of the rick-lifter to a countershaft in front, which is geared to the winding roller or tube. The combined loader and unloader is constructed with a wooden beam about 4ft. long fitted with three T-iron prongs 4ft.

long. Small wheels are fitted on the under side of the beam, and small double wheels or rollers near the front of the prongs. On top of the beam is fitted

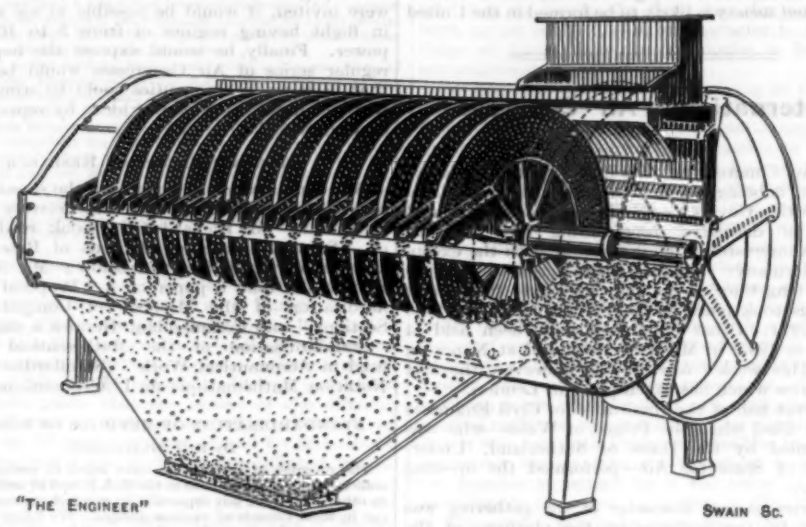


FIG. 4—THE CARTER DISC GRAIN SEPARATOR—R. BOBY AND CO.

a tripper consisting of two small wheels with an axle, two cranked arms and a wooden cross bar. The whole apparatus is attached to the rick-lifter platform by means of a chain. Two small wheels are fitted to the rear end of the main beams of the rick-lifter, while a prop is fitted to the front of it. This prop keeps the rick-lifter tilted up. The action of the loader is simple. With the lever tilted and the prop in position, the rick-lifter is backed smartly towards the rick. The three prongs penetrate under the rick, which automatically forces up the tripper, thereby raising the loader and rick on to the platform. The most difficult part of loading a rick on to a rick-lifter is thereby accomplished by the simple "backing" of the horse, and it is an easy matter to complete the drawing on of the rick, as it has to be drawn a much shorter distance. With the new combination device the completion of the operation of loading the rick is performed by the horse yoked to the rick-lifter instead of by hand. When the loader with the rick on it has been raised on to the platform, the ropes are put round the rick in the usual way, the clutch is engaged and as the horse walks forward the rick is drawn on to the platform. When the rick reaches the front of the platform its weight depressing the front of the platform locks the tipping arrangement and automatically throws the clutch out of gear. It will, therefore, be seen that this combined machine does not necessitate having an extra man or an extra horse in the field when loading ricks, as the entire operations of loading and unloading are quite within the capacity of the driver.

Another machine which has not previously been seen at the Royal Shows, though it has already been referred to in our columns, is a three-wheel water-ballast road roller, made by Barford and Perkins, Limited, Peterborough. The principal features of this roller, a view of which is given in Fig. 5, are the wheel arrangement, short wheel base and very low centre of gravity. The whole of the transmission mechanism, with the exception of the final chain drive to the back rollers, is enclosed in oil-tight casings, and the gears run in oil. The engine is of

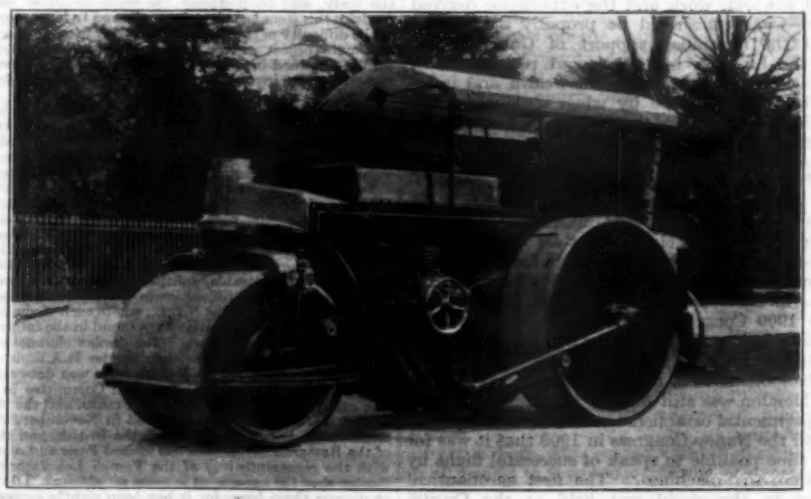


FIG. 5—BARFORD AND PERKINS THREE-WHEEL MOTOR ROAD ROLLER

40 brake horse-power, adapted to use either paraffin or petrol. The driver can, without leaving his seat, control all motions of the roller, including the water supply to the sprinkling pipes on the back and front rollers. The frame of the roller is mounted on coil springs in the head and main axle brackets, thus insulating the transmission and engine from the road shocks. The frame has a three-point suspension, and a similar three-point method of supporting

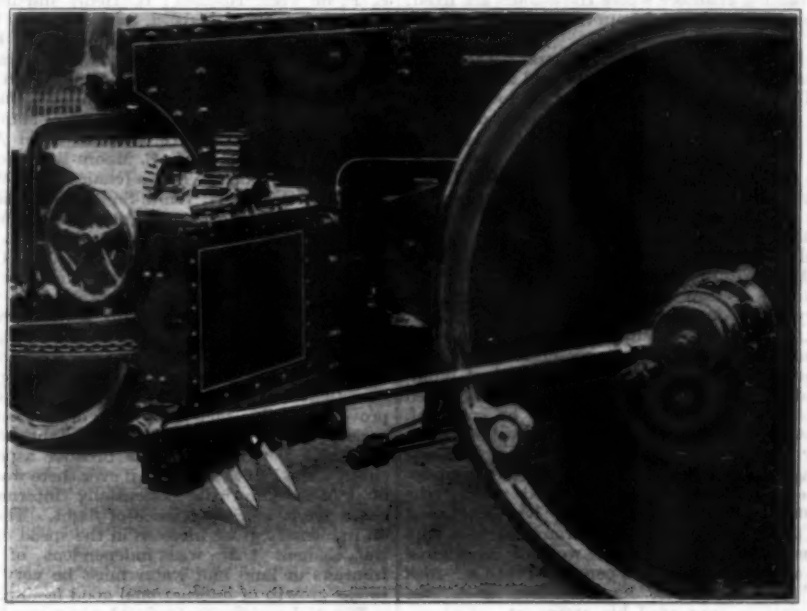


FIG. 6—PRICE SCARIFIER FITTED TO BARFORD AND PERKINS MOTOR ROAD ROLLER

is adopted for the gear-box and reducing gear. The drive from the engine is through a simple clutch and Hardy flexible couplings to a three-speed gear-box. The box is arranged to give three forward speeds and two reverse speeds. The top forward speed is a direct drive through the gear-box, and when using this speed the layshaft can be put out of gear if desired. A further gear-box is bolted to the three-speed gear-box, and contains the reducing gear. The first reduction is carried out by means of a bevel gear, and further reduction by a spur gear on the chain pinion shaft. The final drive to the back rollers is by means of a roller chain, 2½in. pitch. Slots are provided in the brackets supporting the transmission to allow for tightening the chain when wear takes place. The exceptionally short wheel base—9ft. 9½in.—is obtained by placing the engine at the rear, where it is also very accessible and can be removed entirely without interfering with the transmission. The short wheel base, in conjunction with the differential gear, enables the roller to turn completely round within a circle 31½ft. diameter. To facilitate erection and repairs, the whole of the transmission unit is mounted on a sub-frame, which is bolted to the main frame carrying the rolling wheels and tanks. This sub-frame can be dropped and slid out towards the rear when any extensive repair or overhauling is required. The transmission can be tested in this position before re-assembling.

Both back and front rollers are of large diameter—5ft. 6in. and 4ft. diameter respectively. They are of special construction, being fitted with steel plates accurately machined to fit in recesses in the rims and hubs. It is claimed that more even distribution of the load on the rims of the rollers is obtained by this method, and that the securing bolts are not subjected to any shearing load due to the weight of the machine, and construction trouble, due to loose or broken spokes, is entirely obviated. With a view to keeping all parts within the rim of the back roller, the differential locking pin is arranged so that when in the locked or unlocked positions it does not project beyond the axle cap.

This roller is designed specially to take an attached scarifier, the frame being very strongly constructed to stand the severe stresses imposed upon it when in operation. The usual trouble experienced with some steam rollers is the straining of the boiler by the pull of the scarifier. This source of trouble is, of course, entirely avoided in the case of a motor roller.

For scarifying it is essential to be able to exert the full engine power when travelling slowly. To enable this to be done the roller under consideration is fitted with three speeds, the lowest speed of 1¼ miles per hour being used for scarifying. Any variations in the load on the engine are corrected by the governor, thus relieving the driver of the duty of constantly manipulating the throttle to get over hard patches in the road, and enabling him to concentrate on the scarifying.

It is now the general practice to scarify in one direction only, as it is found difficult to steer the roller when pushing the scarifier, and many scarifiers are constructed for working in one direction only, notably the Price resilient scarifier, which is fitted to this roller, and which is illustrated in Fig. 6. When scarifying much time is saved by the use of the top speed—4 miles per hour—for a quick return to the beginning of the section. The top gear can be engaged direct, without changing through the other gears, and the whole operation is controlled by one lever only.

THE French Government is being urged to grant a national credit to enable the country to develop and make greater use of her water power and thus reduce her bills for imported coal.

The Newcomen Society.

THE summer meeting of the Newcomen Society was held on Thursday and Friday, the 21st and 22nd of the month. The members, arriving by different routes, first met at the textile printing works of G. P. and J. Baker, Limited, Crayford, which they had been invited to visit by the present proprietor, Mr. G. P. Baker. Here they were shown the whole art of printing fabrics, both from flat blocks by hand and from cylindrical blocks in machines. The latest machine takes sixteen rollers and prints sixteen different colours at once. The process is really dyeing rather than printing, for the colours are absorbed by the threads of which the material is woven, and are then fixed by steaming at several pounds pressure. The dyes are thickened with paste and the mordant is in the material, in the colours, or in both. The blocks are either raised or intaglio, the former being wholly of wood or of felt enclosed within brass walls bent to the shape of the pattern and driven partly into the wood. The intaglio blocks are deeply etched on copper.

The process of hand printing excited great interest. The fabric is spread out on metal-faced tables, possibly 20ft. to 25ft. long, and is wound up, after printing each length, upon a roller at one end. The blocks are handled by men or girls. Each of them is provided with two points, by which registering is effected. They are first pressed lightly against a canvas on which the colour is smeared, and then transferred gently and accurately to the material. A couple of smart blows upon the back is sufficient to effect the actual printing. After printing, the fabric enters a drying chamber, where it is looped mechanically and dried continuously by hot air. It, then, goes to the steaming chamber where the colours are fixed, and in the process changed from their original appearance.

After luncheon at Dartford, the train was taken to Chatham, where a brief visit was paid to the Dockyard. There glimpses were caught of several submarines, including the famous "X," and a destroyer which is being fitted with a Sperry stabiliser was seen.

In the evening dinner was taken at the Bull Hotel, Rochester—made famous by Pickwick—where his Worship the Mayor (Councillor A. E. Price) and Sir Frank Baines were the principal guests. Following the excellent traditions of the Society, there were no speeches. After dinner Sir Frank Baines delivered an admirable lecture in the Guildhall, which had been very kindly lent for the occasion by the Mayor. Besides the Mayor himself, many notable citizens of Rochester and Chatham were present. The subject of the lecture was the preservation of ancient buildings, and Sir Frank held his audience fascinated for an hour and three-quarters whilst he spoke of, and illustrated by many slides, the marvellous work done by the Preservation of Ancient Monuments Department of His Majesty's Office of Works under his direction. Sir Frank condemned wholly the conversion of ancient ruins into "ivy-tods," and claimed that there was as much romance in a ruin which showed the remains of the work of its original builders as in one which was converted into a "rock garden." The examples he exhibited upon the screen certainly supported his argument, which received further support from the fact that in many cases if the ivy, and even trees, had not been removed when they were, further destruction of the ruins would have occurred. Sir Frank is wholly opposed to the "restoration" of ancient buildings, but he believes in using all available modern science and materials to retain them as they are, always with the proviso that the method of reinforcement shall, wherever possible, be completely concealed. He gave many remarkable instances of the extraordinary success which has attended the principles he employs.

On Friday morning the members drove out to Tovil, which is near Maidstone, where they were most courteously received at the Hayle paper mills. The firm makes nothing but the best qualities, and every step in the process was followed with the greatest interest from the reception of the rags to the storing of the finished paper. Mr. Green and his son were tireless in their explanations, and the Society passed a morning which it will long remember. A brief visit was then paid to the Ivy Mill, where millboard is produced, and after a pleasant luncheon at the Bockingford Arms, the members drove back to Rochester, where, under the guidance of Mr. Harris, the Cathedral and the famous Norman Keep were examined. Mr. Harris proved to be not only a very well informed but an amusing guide.

Thus came to an end the third summer meeting of the Newcomen Society. It was blessed, as were the two former meetings, with excellent weather, and on all hands was voted an unqualified success. We are happy to be able to add that the membership of the Society is now about one hundred and sixty, and that it is in a flourishing condition. The first volume of its "Proceedings" has sold so well that a larger edition of the second volume, which is just going to press, is to be printed. As the result of the visit of the Secretary, Mr. H. W. Dickinson, to America, the American Society of Mechanical Engineers is exhibiting extended interest in its work, and many new American members have been added to the roll. It is very satisfactory to learn that American engineers are so convinced of the value and importance of technological history that a kindred or affiliated society is likely to be formed in the United States.

International Air Congress.

No. I.

THE Air Congress, of which the Duke of York is President, is being held in London, on the invitation of the British Government. It has attracted a large number of delegates, representing the principal countries interested in civil aviation, with the exception of Germany. The first Air Congress was held in Paris as long since as the year 1889, and subsequent gatherings took place in the French capital in 1900 and in 1921. Other Congresses have been held at Chicago in 1893, in Milan in 1906, and at Nancy in 1909. This week's assembly is, however, the first of the series which has taken place in London.

The great hall of the Institution of Civil Engineers was well filled when the Prince of Wales—who was accompanied by the Duke of Sutherland, Under-Secretary of State for Air—performed the opening ceremony.

The international character of the gathering was indicated by the presence on the platform of the Belgian, Italian, and Japanese ambassadors. Other foreign representatives included General Echaque, Spain; Lieutenant-Commander M. A. P. de Vasconcellos, Brazil; M. Laurent Eynac (Under-Secretary for Air), France; Captain Land (U.S. Navy Bureau of Aeronautics), United States; Colonel G. Grüner, Norway; Commander E. von Schroedors, Chile; E. F. de Veer, Holland; R. Henri Martin, Switzerland; Colonel E. Morsberg, Sweden; Chao Hsin Chu, China; Commander A. E. V. Grandjean, Denmark; Professor St. N. Mienca, Rumania; Sayad Qunsin Khan, Afghanistan; Captain L. Zayfert, Poland. The British delegates and Government officials were Sir Samuel Hoare (Secretary for Air); Major-General Sir W. S. Brancker (Director of Civil Aviation); Lieutenant-Colonel J. T. C. Moore-Brabazon, Major-General Sir Frederick Sykes (chairman of the Executive Council); Sir H. White-Smith, Brigadier-General P. R. C. Groves, Sir Joseph Cook (High Commissioner for Australia); Lieutenant-Colonel J. L. Sleeman (New Zealand); Lieutenant-Colonel M. O'Gorman. Dr. W. H. Maw, President of the Institution of Civil Engineers, was also present.

The Prince of Wales, in his address, referred to the ambition which had led man throughout the centuries to study the problem of flight. Roger Bacon and Leonardo da Vinci were among the early investigators, and British interest in aeronautics was proved by the fact that the oldest aeronautical society in the world had been established in this country. Dealings with the broader aspect of the subject, the Prince said that if ever there was a branch of human knowledge essentially international in character it was the science of flight. The effect of an immensely great increase in the speed of travel in the element that was independent of customs frontiers of land and water must be very beneficial to the growth of international good feeling.

The Duke of Sutherland, who has acted as Chairman of the Main Committee of the Congress, then delivered his inaugural address. The present time was, he said, full of great possibilities in the realm of aeronautics. We were on the eve of far-reaching advances in aviation, which might within the next decade or two bring about a partial or complete readjustment of our manner of living. To achieve the desired objects it was, however, essential that the results of research work and the experience derived from that Congress should be properly applied by means of the continued support of Governments, and by the business initiative, and patriotism, of private citizens and companies of wealth and influence. The day had gone by when we could leave these things to develop themselves and work out their own salvation. The stakes were too great for us to stand negligently by, while the world's greatest secrets were almost within our grasp. The development of civil and commercial aviation between all countries on a scale hitherto unrealised and the evolution of a popular, cheap, light aeroplane for the public use were both essential factors for the future, and were undoubtedly the forerunners of our entry into an aerial age. It was of interest to recall the fact that the 1900 Congress at Paris was actually held at Chalais Meudon, the site of the construction of the first military aircraft in the world's history—the captive balloons used at the battle of Fleurus in 1794. Chalais Meudon was still one of the French Government experimental establishments. It was not, however, until the Nancy Congress in 1909 that it was for the first time possible to speak of successful flight by heavier-than-air machines. The first aeronautical exhibition in the world was held at the Crystal Palace as long since as the year 1868, and was memorable for the fact that it included John Strongfellow's steam-driven model, parts of which could be inspected by those delegates who visited the Science Museum at South Kensington. He hoped that the visits to the various centres of aeronautical activities which had been arranged would be found of interest. It had not been possible to arrange an Aero Show concurrently with the Congress, but at the Royal Air Force pageant, to which those attending the Congress were invited, it would be possible to see aeroplanes in flight having engines of from 3 to 1000 horse-power. Finally, he would express the hope that a regular series of Air Congresses would be held, so that progress in aeronautics could be stimulated by free and frank discussion of ideas by representatives of all nations.

STANDARDISATION OF RESEARCH.

A group of papers dealing with the standardisation of methods of research and nomenclature was then presented. Sir Richard Glazebrook read a paper on "Standardisation of Methods of Research," an abstract of which is given below; Mr. A. G. von Baumhauer read a paper on a "Proposal for Standardisation of the Methods of Computing Wing Sections," and Commandant Herrera a third on the "Standardisation of the Mathematical Notation used in Aeronautical Work" (Standardisation de la Notation Mathématique de L'Aéronautique).

"STANDARDISATION OF METHODS OF RESEARCH."

By R. T. GLAZEBROOK.

The progress of aeronautics owes much to research, to full-scale research as carried out at the R.A.E. and at various stations in other countries, but especially to research on models carried out in wind tunnels of various designs. We know now that if due care is taken in making the tests, the results of model and full-scale work are very closely in agreement. But there are various forms of channels. Can we be sure that the results from all of these are comparable? Corrections have to be made to the direct measurements. Do we know these corrections to the accuracy now needed? In passing from model to full scale there will be a scale effect expressible as a function of vl/ν. Can we be sure that this function is a constant at the values of vl at which we are compelled to work? Or again, an aeroplane moves in free air; the flow in a channel is straightened and confined by the walls. How does this affect the results? The effect will certainly be different in the different forms of channel, and inter-comparisons are required for their interpretation. Many such questions may be asked.

The various forms of tunnel have been described in numerous publications, and as the tunnels vary, so, too, do the balances or measuring apparatus.

Some three years since, Air-Commodore Brooke Popham, then Director of Research, wrote to the Advisory Committee of Aeronautics:—

"It has been suggested that it would be desirable for comparative trials of exactly similar models to be carried out in representative wind channels in England, France and America, the object being to ascertain from the comparison of the results whether the method of carrying out aerodynamic research in these countries are identical, and whether any improvements in method could be made. I shall be glad of the opinion of the Advisory Committee on this matter, and if they agree that it is desirable, for suggestions as to the nature of the model and of the exact tests which should be carried out."

At the time the Advisory Committee for Aeronautics was in process of becoming the Aeronautical Research Committee, and the new body took the matter into consideration at an early meeting. The suggestion was approved and the following proposals for tests were made:—

(1) Determination of lift, drag, and centre of pressure of a standard aerofoil at various angles of incidence.

(2) Tests of a complete model aeroplane, including the complete determination of forces and moments, and of the more important stability derivatives.

(3) Resistance measurement at zero angle of yaw of a very good stream-line airship model.

Letters were written, asking for an expression of opinion on the question, to Colonel Crocco, Instituto Sperimentale Aeronautico, Rome; M. G. Eiffel, Laboratoire Aerodynamique, Paris; M. le Directeur, Institute Aerotechnique de L'Universite de Paris, St. Cyr; Mr. William Knight, Paris, at that time representing in Europe the American National Advisory Committee for Aeronautics.

The French and Italian authorities replied, approving the proposed plan and making certain valuable suggestions as to the form of the models, the material to be employed in their construction, &c. M. Toussant (St. Cyr) added a note suggesting a definition of the conditions of turbulence during the test. Mr. Knight acknowledged the letter and stated that it was being transmitted to the United States Advisory Committee at Washington for their consideration, and in due course a reply was received promising the co-operation of the Committee.

The replies were discussed by the Aerodynamics Sub-Committee, and as the result it was agreed to construct two airship models differing only as to the length of the parallel portion of the body, and to postpone the construction of the complete model; this item has since been allowed to lapse, partly because of the difficulty of transporting the delicate model, partly because the main object of the inquiry—the intercomparison of the results obtained in different channels and the determination of the corrections involved—could be achieved better by the use of a simpler model.

For the aerofoil tests it was decided to use a 6in. by 36in. R.A.F. 15 aerofoil which had been cut by the Royal Aircraft Establishment, while the design of the airship models was put in hand at the N.P.L. Details as to these various proposals were sent to the participating laboratories in September, 1920.

Subsequent applications to co-operate were received from the Director of the Rijks-Studneniest voor das Luckvnart, Holland, the Associate Air Research Committee of Canada, and the Imperial Navy, Japan. These requests were in all cases approved; while, though it is fully recognised that from the scientific standpoint the co-operation of the laboratories at Göttingen and Vienna is very desirable, political considerations have up to the present put serious difficulties in the way of arranging this.

The aerofoil tests at the N.P.L., where each of the five channels was utilised as opportunities were found in the intervals of other researches, occupied a year. The duplex channel was not employed. The aerofoil was sent to the R.A.E. in September, 1921, and a report on the British tests was drawn up and presented to the Aeronautical Research Committee in May, 1922. The model was then forwarded to France, and the results of the French Laboratories were received in November, 1922. These results have been compared with the British, and the Secretary of the Research Committee has visited Paris and discussed them with the representatives of the French Laboratories. Beyond stating that the agreement is quite satisfactory, I do not propose to discuss them here, for it has been rightly agreed to reserve public discussion until all the results are to hand and can be treated together. It was intended as the next step to send the model, after careful measurement at the N.P.L., to Rome, but on communicating with the Director of the Instituto Sperimentale Aeronautico, he wrote that they were equipping the laboratory afresh, and asked for delay. The next suggestion was to send the model to Ottawa, in the hope that it might go thence to Washington after the American authorities had com-

pleted their tests on the airship models. The Canadian Committee, however, wrote that they were putting up a new channel and could not undertake the tests at once.

A similar reply has been received from Amsterdam, and in consequence arrangements are being made to send it to the United States, and a letter has been addressed to the Japanese Naval Attaché, asking if the Japanese Laboratory could receive it later in the year. It had been hoped to complete the European tests before sending the model overseas.

The two model airships were constructed in the workshop of the Metrology Department of the N.P.L. and were tested in a 7ft. channel at the Laboratory. On the completion of this they were sent to the R.A.E. and tested in a 4ft. channel, and on their return, after re-measurement, they were sent to the National Advisory Committee for Aeronautics at Washington.

Information has been received that the tests in the Washington Navy Yard and the McCook field tunnels are finished, and it has been agreed to extend the work by including the channels of the Bureau of Standards and of the Massachusetts Institute for Technology, provided it is possible to have the work completed within three months.

Mr. von Baumhauer, in opening a joint discussion on the three papers, said that the experiments which were in progress in the laboratories of Europe, America and Japan would occupy a long time, but that it was desirable that a method of making comparisons on an accurate basis between the different results arrived at should be evolved. It was important, in the first place, that the causes of the different sources of error in making comparisons between researches in different countries should be understood. It was necessary also to divide the different laboratories into several classes according to the nature of the equipment installed and the character of the work in hand. There were several groups of laboratories which could be placed together for purposes of comparison.

Major A. R. Low said that the standardisation of research work was a contradiction in terms which he was glad to see that Sir Richard Glazebrook had repudiated. Referring to the errors arising from the scale effect, it had been asserted by some critics that it rendered all work in wind channels quite useless. He did not agree with that criticism. Model work was quite essential, and a good deal of progress had undoubtedly been made in tracing the discrepancies between model and full scale effects. It was quite refreshing to hear Sir Richard Glazebrook admit that the theory of vortex systems was important, as the customary attitude of those present at aeronautical societies' meetings for the past ten years was that there was nothing in the Lanchester theory of vortex systems. Discussion had often turned on the standardisation of methods of measurement, but he would like to point out that Great Britain was cursed with the world's worst system of units and that our methods of measurements were wilfully inconvenient and wasteful of brain power.

Mr. E. P. Warner, in a communication which was presented by Mr. J. J. Ide, raised several points of interest. Mr. von Baumhauer had, he said, called attention to several matters of importance concerning standardisation of research. The want of it had, undoubtedly, given a great deal of trouble. In America they had practised the method of standardisation described by Mr. von Baumhauer, and had found it quite satisfactory. There was a difficulty, however, in dealing with the question of dimensioning. The position of the datum line was often uncertain, but various methods had been suggested which would make it possible to locate the datum with certainty in any instance. Some method of fairing the section was also desirable. It was the experience of everyone who constructed wind channels that the dimensions furnished by the designer of aerofoils were often such as made it impossible to construct a smooth curve through the ordinates. That difficulty could be overcome by the designer if he would adopt some graphical device for fairing the curve at the time he first drew the section. Several such devices were well known.

Lieut.-Colonel C. L'Estrange Malone said that in order that any air service might have the benefits of research worthy of the name a very clear division of function appeared to be necessary. The department dealing with research should not be required to undertake routine testing. The divisions of research were, broadly, (1) pure scientific research; (2) technical research in the form of systematic measurement along established lines, and (3) application to design. The subjects which the three methods of research should cover were aerodynamics, including aerofoil research, compressed air wing tunnel work, stability and full scale work. Another branch should be concerned with strength of structure and material, and the details of stresses involved in normal flight and under extreme conditions, the results of this work being checked by full scale measurements and tests. Research should also be conducted on power plant, including the development both of the present engine and of an engine capable of using a fuel of much lower flash point. He recognised that research workers were hampered by the want of appreciation on the part of those who held administrative posts, and he welcomed the suggestion of Lieut.-Colonel O'Gorman that someone should be in a position on the Army Council and the Board of Admiralty to represent, first and foremost, the scientific interest in aviation. In his opinion the time had come when we should appoint scientific attachés at the leading embassies. A great deal was heard, he said, about standardisation and co-ordination, but we lacked any official organisation to help this work, and he hoped the idea of scientific attachés would receive serious consideration. There was a lack of the right men in important positions, which seemed to indicate a want of understanding on the part of those responsible for making official appointments. His own idea was that to obtain the right men for air research work an air corps, similar in character to the Royal Corps of Naval Constructors, ought to be brought into existence.

Sir Richard Glazebrook, in replying to the discussion, said that he was in general agreement with Major Low on the question of units employed in Great Britain, but it was not possible to introduce the metric or any other new system into aero engineering as long as the ordinary system was used in general engineering, and a recent report indicated that for British engineering the British system was the right one to adopt. With regard to the scale effect, that would be dealt with in a paper which Mr. McKinnon Wood was reading before the Congress, and it would be shown that it was now possible to work from the model to the full scale machine with a considerable degree of certainty as to the results which would be achieved. The limits of accuracy which could be obtained were now fairly well recognised. Complaint had been made that the work of Lanchester had not received sufficient recognition, but he would point out that it was not until Professor Franklin had put the Lanchester theory into mathematical form that it was possible to attach to it the value of which it undoubtedly possessed, or to give to Mr. Lanchester all the credit which he deserved. He had heard Colonel Malone's suggestions with much interest, and was in full agreement with him.

Mr. von Baumhauer thanked Mr. Ide for bringing forward the statement by Mr. Warner and appreciated the suggestions made of fairing the sections. He would only desire to add that, if this method were adopted, when computing wing sections the same give data should be given as it was customary to in America.

Lieutenant-Colonel O'Gorman, in closing the discussion, said that the organisation of a Congress of the character in which they were participating involved an immense amount of work. What he desired to impress on delegates was the necessity, if real progress was to be achieved, of following up, after the Congress was at an end, the subject in which they were all interested, with the same persistance and energy as that which had made the holding of the Conference possible.

LIGHT ALLOYS.

A paper by MM. A. M. Portevin and R. de Fleury dealt with the use of extra light alloys in aeroplane construction.

Sir Robert Hadfield, who occupied the chair, emphasised the importance of the subject and the qualifications of the authors for indicating the direction in which the search for new alloys possessing the necessary qualities should be made.

Dr. Walter Rosenhain said that his interest in the subject arose from the attention which was being given to it at the National Physical Laboratory. The experimental work on magnesium alloys set out in the paper was in general agreement with the results reached in similar work at Teddington. It was obvious that the use of light alloys was a great attraction to the aeronautical engineer, but it must not be overlooked that there were very serious difficulties in the way of the general use of these alloys, particularly the alloys of magnesium. He would point out in the first place that the strength of these alloys did not exceed 18 tons per square inch, and that had to be compared with high tensile aluminium alloys which had a tensile strength of from 36 tons to 39 tons. The view of the authors of the paper was that the strength figure was not very important, a view with which he personally was in disagreement. One reason for attaching importance to the maximum strength of the material was that the ability of these alloys to resist repetition stresses, a quality much desired for materials used in aeroplane construction, was proportional in many cases to the ultimate strength. Another serious difficulty in the use of these alloys was their liability to corrosion, and magnesium was one of those metals which was very subject to corrosion. There was also the question of the cost of magnesium alloys, which was very high, and a final objection was that they were of an inflammable nature, and their use for certain positions, particularly in engine construction, involved the taking of considerable risks. An interesting point arose in connection with the hardening of these alloys. The reason for the hardening of aluminium and certain other alloys had been ascertained and had thrown a great deal of light on the problem of hardening in steel. That being so, it was probable that a similar hardening process would be found in connection with magnesium alloys, and it should then be possible to get an improved tensile strength more comparable with that of aluminium. With regard to the elastic modulus of a material, that appeared to be a quality inherent in the basic property of the alloy. If a material with a higher elastic modulus were necessary, the engineer might be driven for that reason alone to employ even heavier metals than those which were being used at the present time.

There was a good attendance at the meeting presided over by Sir Richard Glazebrook, at which Mr. F. Handley Page presented his paper on "Slotted Wings," an abstract of which is as follows:—

"THE SLOTTED WING."

By F. HANDLEY PAGE.

The primary object of the slot in the wing is to extend the range of angles at which useful lift can be obtained and so increase the maximum lift coefficient. Such increases can be obtained on aerofoils, such as are commonly termed high speed, as well as on high-lift sections.

Several explanations of the phenomenon have been given. According to one theory, the rear edge of the front aerofoil is in a region of increased velocity and diminished pressure situated over the upper part of the leading edge of the rear aerofoil, whilst the reverse state of affairs is the case if the rear aerofoil be considered. Considered from the point of view of the front aerofoil, the air velocity at its rear edge is therefore increased, and considered from the point of view of the rear aerofoil below, it is diminished. The resultant effect is that the pressure gradient across the wing section is diminished and the tendency for the creation of eddy motion reduced. In consequence, greater maximum lift coefficients can be obtained owing to the delay in the burbling point of the wing.

The above considerations do not, however, deal with the necessity for a certain shape and area of slot cross section if the results are to be obtained. It is evident that if the size of the slot were immaterial, by continuously diminishing it in section one could arrive at a point where it was practically closed, and yet the results were still obtained. This is, of course, in contradiction to the facts, and experiment at present alone can show the shape of section necessary to give the best increase in lift coefficient.

The increase in maximum lift is chiefly dependent on the chord of the auxiliary aerofoil combined with a good slot form. These two points are of the utmost importance and should be placed first when applying the slotted wing. It is then possible, after having obtained the best aerodynamic result, to modify slightly the auxiliary aerofoil and slot form to meet structural conditions.

To obtain these conditions exhaustive wind channel tests should be made, and although it may seem quicker to take the result of a given slotted form and modify the slot form and auxiliary aerofoil to suit the case called for, without further tests, this is false economy, as in some cases it has meant the destruction of the maximum lift obtained. Further, it is not possible to make a successful calculation as to the increase in maximum lift likely to be obtained. Therefore the quickest and most sure procedure is to make channel tests.

Considerable wind tunnel work on the best form of slot and auxiliary aerofoil has been carried out. It has now been found that the single surface type of auxiliary aerofoil—Fig. 1—gives a

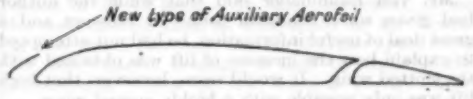
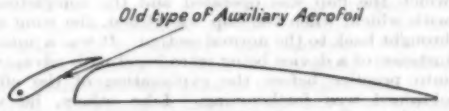


Fig. 1.



"THE ENGINEER" Fig. 2. SWAIN Sc

result equal to, and in some cases better than, one that would be termed a thick section—Fig. 2. First, it has the advantage that with the slot-closed condition the true basic section is retained, so that no increase in drag is brought about. Secondly, it obviates the tail adjustment that is necessary with the swivelling form of slot—Fig. 2—due to the backward movement of the centre of pressure on opening the slot. This movement is practically negligible with the single surface type of aerofoil, as the forward movement of the auxiliary aerofoil practically compensates for the backward movement of the centre of pressure.

One very important application of the slotted wing lies in the direction of obtaining increased lateral control at the slow speeds of landing and taking-off. With the single front slot only, full lateral control can, of course, be obtained in the ordinary manner, there being no diminution of control effect such as is encountered when an increase in lift coefficient is obtained by the use of the flaps alone. With the slotted flaps, particularly with high-lift sections, an increase in rolling moment is obtained without a corresponding increase in yawing moment. This increase can be of a very high order, in some cases double the control usually obtained at large angle of incidence, with very little increase in yaw.

This can be still further improved, if necessary, by differential operation of the ailerons, as proposed and carried into effect by Captain De Havilland. Still more important, however, than these existing features is the use of the front slot in conjunction with the ailerons for the prevention of burbling on the wing which is lower and causing the high wing to burble. By the manipulation of the slot or parts connected therewith a very big rolling moment can be obtained, with an actual decrease in yawing moment, compared with existing controls at slow speeds. In some cases the yawing moment can actually be negative in value. The control feature is a most important one, as adequate control at the slow speeds obtained is necessary if the full value of the increased lift coefficient is to be obtained.

The application of the slotted wing to aircraft design needs special attention. The extension of the useful angular range at which lift can be obtained makes the stalling of the machine a matter of great difficulty, and therefore from the safety point of view a great improvement. On the other hand, the provision of a very big angular movement of the fuselage and the necessary large grounding angle entails a somewhat higher chassis unless slotted flaps are used as well as the front slot. The combination of these two enables a high lift coefficient to be obtained without greatly increased angular range.

With the type of slot in which the auxiliary aerofoil is moved forward as a whole when it is opened, the centre of pressure remains approximately at the same point with slot open and closed, and therefore no tail adjustment is necessary. This is a most important feature, for at large angles of incidence and consequent large tail angles, if the centre of pressure moves backward, it will be very difficult to get one's tail down at the moment of alighting, or would entail a large amount of elevator control to carry it into effect. This, however, is avoided with this forwardly moving type of aerofoil.

The simplest method of application that immediately occurs is the substitution of an ordinary type machine with slotted wings for those of the ordinary standard type, so that machines which are at the present time difficult to land may land more slowly and perhaps with greater safety. This does not, however, by any means follow. The rudder and elevator are designed for the landing speed of the existing machine, and will be perhaps inadequate if the landing speed is reduced. Each case must be studied on its own merits, as it may be possible with existing

designs to substitute slotted planes for the normal type with a retention of the existing performance in regard to the high speed and climb, but improvement of the slow speed, if at that speed control can be obtained, perhaps, by the use of the combination of slotted flap and aileron for lateral control.

There are two ways in which the slotted wing can be used in new designs, one with the same loading as in the normal machine to reduce the landing speed and improve the method of alighting, the other by increased loading to improve the present performance with a given weight per horse-power, maintaining the landing speed the same by the use of the slot.

With regard to the first, not only is it possible to reduce considerably the landing speed with a given design by the increased lift coefficient, but the steeper angle of descent that can be obtained permits of machines with slotted wings being landed within a much more restricted area.

Two machines have been built, weighing approximately 6400 lb., with the same engine installed and of the same span. The climb of the slotted wing machine was approximately 33⅓ per cent. greater and its ceiling 2000ft. higher, though the planes had only 80 per cent. of the area of that of the normal unslotted wings. The two aircraft have the following speeds at 10,000ft :—Slotted wing machine, 110 miles per hour ; unslotted wing machine, 100 miles per hour.

These top speed figures are quoted for a slotted wing machine with the swivelling type of slot, which has a higher resistance and therefore gives a slower top speed than that of the parallel moving type. The conclusion that may therefore be drawn is that with an aeroplane of normal landing speed an all-round improved performance in top speed, climb and ceiling can be obtained by the use of slotted planes, an increased loading being obtained mainly by reduction of chord rather than that of span.

The application of the slot to a design does not present great difficulties, but development work in the initial stage necessarily takes time in working out the first type. This has now been carried out, and two views are given in Figs. 1 and 2 of different types. The first is that of a parallel movement type as fitted to a D.H. 9 for experimental purposes, the second a swivelling type. A variation of the first, in which the whole auxiliary aerofoil moves forward without side movement, has also been worked out and put into operation.

The movement is carried out by a light worm and worm wheel operated by rotating a cranked handle at the pilot's cockpit. The slot is left open for getting off, and when the requisite height is reached, is closed by rotating the handle. It is then left untouched until the pilot is about to alight, when it is again opened. The forces acting on the slot are all in the direction of opening the slot, so that it is easier to open than to close it.

The practical question of weight increase with the slot is most important. It is best dealt with by stating that in the two machines compared above the total weights of the two were approximately the same.

Mr. Von Baumhauer said that while the author had given some beautiful tables of pressure and a great deal of useful information, he had not attempted to explain how the increase of lift was obtained with the slotted wing. It would seem, however, that high lift was only possible with a highly curved wing.

Mr. R. V. Southwell said that he had, with others, had an opportunity of visiting the Handley Page works, and all those who were present on that occasion were much impressed with the ingenuity with which the flap was operated and the completeness with which, when the flap was closed, the wing was brought back to the normal section. It was a notable instance of a device being introduced with advantage into practice before the explanation of the effect obtained was forthcoming. Like others, he was unable to propound a theory of the slotted wing. On the control side, it was not difficult to understand the utility of the invention, and that subject would be discussed in the paper by Mr. McKinnon Wood.

Mr. H. P. Glauert put forward a tentative theory of the action of the slotted wing. An examination of the pressure diagram suggested that an essential feature was that on the main aerofoil peak an important section on the shoulder was much reduced. Another point about the wings was that there was no real improvement at the same angle, but in some way the peak of a section of the shoulder of the main aerofoil was cut off. A remarkable feature was the extreme sensitiveness to the slot shape, but the exact border-line between good and bad practice was very difficult to ascertain. On the question of stalling he was somewhat puzzled. The attainment of improved lift was opposed to better lateral control, and it was a question whether to go for increased safety or greater lift.

Mr. McKinnon Wood said they had tested at Farnborough an aeroplane fitted with the slotted wing, and had obtained an increase of lift similar to that obtained on the model, and there appeared to be no doubt that the slotted wing was an advantage from that point of view.

Captain A. M. Green asked for additional information as to the size and other details of the wind channels used by Mr. Handley Page. The question of the relation of model and full-scale results would be solved one day by mathematical investigation, but it was necessary that full details of work done should be available, and he hoped Mr. Handley Page would add these details to his paper in its final form.

Major Buchanan, on a request from the chairman for information, intimated that the slotted wing was at present under test by the Air Ministry, and that the results as far as the experiments had gone were exceedingly satisfactory. The work which was being carried out with full-scale machines was not, however, yet completed.

Sir Richard Glazebrook expressed his appreciation of the paper. The contribution was one which gave food for a good deal of thought. He was personally much interested in the results shown in Figs. 16, 17 and 18, and the work which had been carried out at Göttingen by Dr. Lachman might throw additional light on the question of the lift coefficient with slotted wings. The latter part of the paper suggested that the lift ratio might be improved by the use of two slots, and those who visited the works of Messrs. Handley Page would have an opportunity of learning more about this device, while it was hoped that a machine with a slotted wing might be seen in flight at the Royal Air Force pageant on Saturday.

Mr. Handley Page, in replying to the discussion, expressed his gratification that the machine tested by the Air Ministry had, as far as experiments had gone, given satisfactory results. Reference had been made to the question of stalling. It seemed obvious that in getting the additional lift there must be some loss of control, but actual practical experience of flying machines with slotted wings was that as the higher angle was reached it became more and more difficult to get the tail plane down to the angle at which the maximum lift could be obtained. The pilot who had done most of the test work reported that with a certain machine flying at 40 or 45 miles an hour, if an attempt was made to reduce the speed, there was a moment of uncertainty. Captain Green had raised a question as to the size of the channel used in his—Mr. Handley Page's—experiments. In reply, he would inform Captain Green that it was only 4ft. square, and the speed used only 40ft. per second. He would rather have had a larger channel, but the results obtained were comparable with those obtained elsewhere, including the National Physical Laboratory and Göttingen. Something had been said as to the absence of a satisfactory theory, but the point was that the device had given good results. He had been asked whether the slotted wing was applicable to all types of machines. His reply was in the affirmative, and his opinion that the sooner this auxiliary was adopted the better.

Another section met under the chairmanship of Sir Henry White-Smith.

Two papers were down for discussion, one by Mr. C. le Maistre on "Aircraft Standardisation," and one by Colonel C. Grard dealing with the same subject.

After a brief discussion of the points raised in these contributions, Mr. le Maistre proposed the following resolution :—"That this International Air Congress, assembled in London in June, 1923, invites the International Convention of Air Navigation to consider the advisability of setting up a Permanent International Commission for the standardisation of aircraft materials and component parts, and for this purpose delegates from the various standards organisations should be asked to make a report on the subject." Mr. Grard seconded the resolution, which was unanimously carried.

A paper on "Air-screw Research in Great Britain" was read by Mr. H. C. Watts.

"AIRSCREW RESEARCH IN GREAT BRITAIN."

By H. C. WATTS.

I have been asked to give to this Conference an outline of the research on airscrews which is being or is proposed to be carried out in this country. I am asked to do so because I am the chairman of the panel appointed by the Aeronautical Research Committee of this country to follow and, if necessary, to initiate research on airscrews, and not because I have taken part in the actual work involved.

Much research was carried out during the war period to which brief reference should be made. Stanton established the experimental accuracy of Froude's assumption that the thrust of an airscrew was equal to the difference of total head of the slipstream before and after the airscrew disc, and thus justified a useful means, not only of measuring the total thrust of an airscrew, but also of obtaining the thrust grading along the blade. Pannell investigated the flow pattern round a typical airscrew. Fage, Risch and others developed the current inflow theory. A few experiments were carried out on the mutual interference between an airscrew and the body before or behind it and on the effect of the number and widths of the constituent blades. At the Royal Aircraft Establishment Griffiths did valuable work on the torsional deformation of blades under load. Mackinnon Wood carried out what is known as the cascade experiments, an attempt to develop a theory based on the conception that the airscrew blades were equivalent to an infinite series of negatively staggered aerofoils. A commencement was also made by Lynam on the investigation of the effect of high tip speeds.

Thus much valuable research was done, but the very circumstances of the time caused it to be spasmodic and unorganised. It aimed at giving answers to immediate and urgent questions, and in the circumstances it was justified. The close of the war made it possible and desirable to consider a more fundamental and consecutive scheme of research, and the panel of which I have the honour to be chairman was appointed to initiate and follow such research. One of the weaknesses of our war research was that the various items of research were carried out on different airscrews having no definite relation to each other, thus making it difficult, if not impossible, to co-ordinate the research and to make generalisations. To eliminate this weakness in future research it was necessary to lay down as a fundamental principle that as far as possible all research work should be done on airscrews having a known and definite relation to each other. The panel therefore did what had already been done by M. Eiffel in France and Dr. Durand in the United States ; it designed a family of airscrews.

I think that in doing this later than other countries it gave us some advantages. Such researches as had already been carried out and the experience gained in full-scale design made it possible for us to eliminate many of the variables in airscrew design. We felt justified from our experience in laying down :—

(*a*) A standard aerofoil section suitable for airscrew design, a section of which we could with some confidence say was not likely to prove greatly inferior to any which in the future might be discovered.

(*b*) A standard blade shape or plan form. We decided to use a shape which had already become almost a universal standard, that is, one which tapered towards the tip of the blade. We argued that other things being equal, an airscrew with tapering blades must have a larger diameter than one with approximately rectangular shape, and that the inflow velocity would therefore be smaller. Also that the region of high slipstream velocity would be further from the body, so that any interference with the body placed behind the airscrew would be reduced.

(*c*) A standard variation of blade thickness along its length.

In addition, it was decided to make each airscrew of the family of constant geometrical pitch. Finally, we had to specify the position of the blade relative to the plane of rotation, and it was decided to arrange the outer blade sections so that the middle points of the chords were on a straight line normal to the axis of rotation, since Griffiths had already shown in his various researches that such an arrangement gave a blade as far as possible free from twist. Having laid down these standards and thus eliminated many variables, the variables left were pitch, aspect ratio and number of blades. Various families were designed to investigate the effect of varying these over a wide range. In all twenty-six different airscrews were made and tested.

The author then proceeded to review briefly some of the results obtained by experiment from the screws. These results will shortly be published in full in a National Physical Laboratory paper. Dr. Watts concluded with a brief reference to theoretical investigations. One of our principal reasons, he said, in carrying out this experimental research work was to provide data over a wide range and in a complete and accurate form for the purpose of checking any theory which had been or might in the future be advanced. To this end the aerofoil sections used in the design of the airscrews of the family have all been tested for the usual characteristics.

The airscrew theory in use in this country is the combination of two independent lines of attack. The first and earlier, that based on a consideration of the momentum and energy generated in the slipstream, and the second, originally suggested by Froude and developed by Drzewoicki and others, based on the behaviour of the aerofoil elements forming the airscrew blades.

As regards airscrews as opposed to marine screws, the blade element theory alone was in use before and in the early days of the war. It is sufficiently well known to obviate the necessity of my describing it here. The theory took no account of the disturbance of the flow over a blade due to neighbouring blades, and it was usual to determine the characteristics of the aerofoil elements from tests of rectangular aerofoils of aspect ratio 6. This aspect ratio was simply chosen because it was convenient. There was no scientific justification for taking 6 any more than any other number. In spite of its limitations the theory gave remarkably good results in the hands of experienced designers.

The earlier theory used extensively in marine work is usually associated with the names of Rankine and Froude. In this theory the thrust on the airscrew is deduced from the rate of generation of momentum in the slipstream, and it is shown that one half of the increased axial velocity caused by the thrust takes place in front of the airscrew disc. The theory ignores the rotational motion in the stream due to the torque and also the periodicity of the flow due to the use of a finite number of blades.

What is known as the current inflow theory is a combination of these two theories. It has been developed by Fage, Bothezat, Risch and others, and is set forth in great detail by Bairstow in his "Applied Aerodynamics." The combination was frankly empirical and has, in my opinion, no very sound scientific justification. It originally assumed that the axial velocity through the airscrew disc is equal to the translational speed of the airscrew plus one half of the axial velocity generated by the thrust. It assumed that a portion of the rotational inflow also took place in front of the airscrew disc, an assumption which Taylor has since shown to be untenable.

It was also not possible to justify taking account of the Froude inflow since as regards an individual blade element this inflow had implicity already been taken into account by using aerofoil characteristics measured on aerofoils of finite aspect ratio in the wind channels. There was, however, a certain inflow to be taken into account due to the mutual blade interference, and it was found finally that to make the "inflow" theory agree with actual measured results it was necessary to reduce the "inflow" factor from one half to one third or even one quarter.

We had hardly started on the programme I have been describing when a new modification of the usual airscrew theories was enunciated by Mr. H. Glauert. Glauert has reviewed the whole basis of airscrew theory in the light of the circulation and vortex theory of aerofoils developed by Prandtl and other writers, and has developed a theory which, in form and method of application, very closely resembles the current "inflow" or combined theory, but which differs from it in fundamental ideas.

The most important conclusion obtained by Glauert is that the aerofoil characteristics to be used in the various formulæ should be those corresponding to infinite aspect ratio or two-dimensional flow. He shows that this removes the discrepancy between the theoretical and empirical interference flows which was the weak point of the current inflow theory, and in his revised theory it is possible to abandon the empirical "inflow" factor of one-third or one-fourth and to use the theoretical value of half. This theory is being checked against the experimental results from the family. The work is not yet complete, but sufficient work has been done to say that the theory gives good agreement not only with experimental measurement of total thrust and torque, but also with the experimental thrust grading curves.

Whilst I cannot say that it is wholly accepted in this country, it is at least correct to say that it is the theory most widely discussed and which is most used for design and for the analysis of experimental results.

In the course of a brief discussion, Mr. A. Fage said that the air-screw theory had now been placed on a sound foundation. The weakness of the airflow theory was now beginning to be recognised, but it was also necessary to state that it was impossible to fix the limits of application of the Glauert theory without further research work. A good deal of work on air-screws was being done at the National Physical Laboratory, and a study of the results of the tests which have been carried out justified certain generalisations.

Brigadier-General Bagnall-Wild, who occupied the chair at this meeting, in thanking the author for his contribution, emphasised the need for further full-scale work. It was desirable that means should be devised so that the pilot could rotate the blades during flight, in order that data derived from service conditions as to maximum efficiency could be obtained.

Tuesday was devoted to visits to aeronautical centres. The programme included an inspection of the Royal Aircraft Establishment, Farnborough ; No. 1 Group Headquarters of the Royal Air Force, Kenley ; R.A.F. Medical Research Laboratory, Hampstead ; and the aeroplane works of Handley Page, Limited, and of the de Haviland Aircraft Company, Limited. The instrument and accessory works of Triplex Safety Glass Company, Limited, S. Smith and Sons, Limited, Titanine, Limited (manufacturers of aeroplane dope), and the Robin Hood Engineering Works, Limited, were also inspected.

On Monday evening a reception was held by the President of the Congress, the Duke of York, at the Hotel Victoria, on Wednesday evening a reception was held by the Lord Mayor at the Mansion House, and on Thursday the members were received at Hampden House by the Duchess of Sutherland.

THE Municipal Council of Johannesburg has been advised by Messrs. G. M. Clark and Partner to erect a new power station at a cost of approximately half a million sterling.

A Seven-Day Journal.

The Government and Shipbuilding.

THE conditions under which the Government agreed, a short time ago, to guarantee the interest and repayment of a loan to be raised by the Royal Mail Steam Packet Company for the building of three large new vessels, continue to excite attention in certain quarters. The guarantee was given under the Trade Facilities Act, and as the object of that measure was to provide some relief to unemployment, the action of the company in placing the orders for the vessels at Belfast will, according to some, defeat the intention of the Act so far, at least, as this country is concerned. On Monday the Minister of Labour, in reply to a question in Parliament, stated that on May 21st the number of unemployed shipbuilding and engineering workers in the Clyde area amounted to 59,414, and that the unemployment benefit paid them was about £35,000 per week. On the same date in Belfast there were 8410 unemployed shipbuilding and engineering workers. The suggestion was made that the Government should intervene with a view to securing the Royal Mail Company's contracts being placed on the Clyde, but the Government denied its authority to do so. On the same day the Financial Secretary to the Treasury was also interrogated on the subject. In his reply he made it clear that the sum of money covered by the guarantee, some £2,300,000, would be expended on the purchase of materials required for the vessels which would be manufactured in this country, and that the actual construction work at Belfast would involve an additional sum of £700,000, to which the guarantee did not extend. The Government, it was held, could not direct the company where it was to have its ships built, nor if it endeavoured to do so, would it in any way increase employment in this country.

Our Increased Air Force.

ON Tuesday, in the House of Commons, the Prime Minister made an important statement revealing the Government's intentions regarding the future development of the Royal Air Force. At present the force for home defence consists of eighteen squadrons. It is proposed to add thirty-four squadrons to this figure, bringing the total up to fifty-two, representing, presumably, over 800 machines. This force is intended, in Mr. Baldwin's words, to be "of sufficient strength adequately to protect us against air attack by the strongest air force within striking distance of this country." It is to be organised partly on a regular, permanent basis, and partly on a Territorial or reserve basis, and will make full use of civilian labour and facilities. The expenditure involved this year in connection with this expansion of our aerial strength is estimated to be about half a million sterling. In a normal year, expected to be reached in about three years' time, it will amount to about 5½ million. The question of separating the air forces operating with the Navy from the control of the Air Ministry was raised after Mr. Baldwin had made his remarks, but it was announced by the Secretary for Air that no statement could be made with regard to it for a week or two.

The Boilermakers' Dispute.

THE conference held in London last Friday between representatives of the Shipbuilding Employers' Federation and the Boilermakers' Society broke up in the afternoon without a settlement of the dispute having been reached. No further conference was arranged, so that the position remains one of deadlock. It is understood that the Society is now considering the question of taking another ballot of its members as provided, in such circumstances, by its rules.

Manganese Ore in the Highlands.

IN the Journal for June 16th last year we referred to the discovery of manganese ore at Dalroy, near Culloden Moor Station on the Highland Railway. Some additional and more precise information concerning the deposit is given in the third revised edition recently issued of the Geological Survey's Memoir on the tungsten and manganese ores of Great Britain. The section naturally exposed in the Dalroy burn shows a bed of manganese ore ranging from a few inches to 6ft. in thickness, and overlain by 20ft. of conglomerate. Fifty yards away a trial pit showed 4ft. of surface deposits, 20ft. of conglomerate, 7ft. of dark manganese ore, 4½ft. of breccia, with a matrix of black oxide of manganese, and 8ft. of red hematite ore with schist below. The manganese ore on analysis was found to contain nearly 66 per cent. of manganese dioxide, 7 per cent. of manganese oxide, about 7 per cent. of barium oxide, and 4 per cent. of ferric oxide. About half an acre of ore has been proved, representing, at an average thickness of 6ft., some 10,000 tons. Local information suggests that the deposit is fairly wide spread, but the geologists suggest that there is a strong probability of its being of a pockety nature. Under the impetus of the war the output of manganese ore from mines in this country rose to over 17,000 tons a year, but as our total imports, principally from British India, are in the neighbourhood of 400,000 tons per annum, the home production represents less than 5 per cent. of our requirements. All the Cornish and Devon mines are now apparently idle, the only mines active to-day being in Merioneth and Carnarvonshire.

Boosters for Locomotives.

IN our issue of April 20th, we illustrated and described a form of "booster" applied to the idle trailing axle of a 2-8-2—Mikado—type locomotive on the Michigan Central Railroad. One hundred and ninety of these engines so fitted had, it was stated, been recently ordered by that railway. We understand that the London and North-Eastern Railway is about to fit a booster on one of its "Atlantic" passenger engines working from King's Cross. The booster is a small separate steam engine driving on to an otherwise idle axle and is called into use when it is desired to augment the draw-bar pull at low speeds. In the case of a 4-4-2 American engine, of which particulars were given in the article referred to, the booster at starting increased the draw-bar pull about 36 per cent. and was automatically cut out when the speed rose to 23 miles an hour. The idea is far from being new. An example of a locomotive fitted with a booster was shown at the Paris Exhibition in 1900, while in our issue of May 11th this year we published a letter from Beyer, Peacock and Co., Limited, accompanied by an engraving illustrating a locomotive with an auxiliary steam bogie engine which that firm constructed in 1865.

The L.C.C. Tramways.

ACCORDING to a report of the Highways Committee of the London County Council, which was submitted on Tuesday last, the working of the Council's tramway undertaking for the year ended March 31st last showed a surplus balance of something like £200,000. Such a result, coming after so many years of deficits, is most startling, and the publication of the detailed figures showing how it has come about will be awaited with interest. There is all the more reason for surprise since it is specifically stated that, during the period covered by the accounts, the whole of the cost of renewals was charged to maintenance account. During the preceding three years half the cost of renewals was, by permission of the Treasury, charged to capital account. For the current year the Committee does not look for quite such a big surplus, but it is sufficiently optimistic to anticipate that after all charges are met there will be a balance on the right side of £78,617.

The First Cabin Motor Lifeboat.

DURING recent years there has been a movement in the direction of the provision of cabin accommodation on lifeboats, and the first motor lifeboat with a cabin has now been completed by the Royal National Lifeboat Institution. She marks a new type, termed the Watson cabin type, and has a length of 45ft., with a beam of 12ft. 6in. The small cabin forward will hold about twelve persons in comfort, while she is also equipped with a well or cockpit aft. With these exceptions the boat and her machinery installation are similar to the Penlee motor lifeboat, which was described in THE ENGINEER of December 22nd last. The new boat left the yard of her builders—J. S. White and Co., Limited, Cowes—on Wednesday, and is due to arrive in the Thames to-day (Friday). After a demonstration she will proceed to Chelsea to take part in the meeting of the British Motor Boat Club on Chelsea Reach on Saturday. The Institution has also under construction a 60ft. twin-screw cabin boat of the Barnett type, which will be fitted with two of the new 90 horse-power engines and should be completed towards the end of the present year. This boat, we believe, will be the largest lifeboat in the world, and will be stationed in the Mersey.

The National Physical Laboratory.

ON Wednesday last, the 27th inst., the annual inspection of the National Physical Laboratory at Teddington took place, and a large company of guests was received by the chairman of the General Board, Sir Charles Sherrington, President of the Royal Society, Sir Arthur Schuster, and the Director of the Laboratory, Sir Joseph E. Petavel. In view of the meetings of the International Air Congress, it was not surprising to notice that the work which has been done by the Department of Aerodynamics came in for a good deal of attention. In the large duplex wind tunnel, a one-fifth full size model aeroplane was shown with a 1½ horse-power electric motor driving its air screw. This equipment is used for investigation of the effect of the slip stream on the behaviour of a machine. Other experimental work in progress is devoted to the analysis of stresses imposed upon the hull of an airship in turning, and also to the investigation of the airflow in the vicinity of a propeller. Since the war the experimental work carried out at the William Froude National Tank has contributed much towards the solving of various problems which confront the naval architect and shipbuilder, and at the present time research on the reason for steering-gear failures is being carried on. In the experiments made it will be sought to throw light on the stressing of the rudder when, either by accident or in case of emergency, the rudder is put hard over while the vessel is moving at a high speed. In the Metrology Department, two measuring machines were shown which have been designed and made at the Laboratory and have a degree of accuracy corresponding to one-millionth part of an inch.

The Liner Leviathan.

THE reconditioned liner, the Leviathan, belonging to the United States Shipping Board, ran her trials at the end of last week, and it is stated that she has established a new liner record for speed on trial by steaming for twenty-five hours at an average speed of 27.48 knots. In this connection, it may be remembered that, as announced in the Journal of May 5th of last year, the world's liner speed record for the Atlantic crossing is held by the Cunarder Mauretania, which on her western voyage ending at Southampton on May 1st, 1922, made the port-to-port voyage at an average speed of 25.14 knots, and for a time on the day before her arrival touched a speed of 27.50 knots. The Leviathan is expected to arrive at Southampton about the 10th of next month, and a berth is being specially prepared for her. Her performance on the occasion of her first crossing will be awaited with interest. We note that the owners of the reconstructed Leviathan now claim that they possess the largest ship in the world. This claim is based on the new gross tonnage after alteration, which is said to be 59,956 tons, as compared with the 56,551 tons of the White Star liner Majestic. According to Dr. E. Foerster, the designer of these ships, when the latter ship was projected, the Hamburg-America Company was desirous of possessing the largest ship afloat, and the increase in size was obtained by adding two frame spaces amidships to the Vaterland design. The Majestic has, therefore, a total length of 956ft., as compared with the Leviathan's 950ft. With practically equal breadth and depths, there is no doubt that, from the point of view of overall measurement, the Majestic is the larger ship.

Sixty Years Ago.

IN our issue of June 26th, 1863, an account appeared of the progress of the Suez Canal works by a traveller who had recently traversed the line of the proposed canal from the Mediterranean to the Red Sea. Across the narrowest part of the isthmus, a distance of 100 miles, the line of the canal had been traced and partly excavated, and at the northern extremity a town was rapidly rising, to which the Canal Company had given the name Port Saïd Pasha, after the late Viceroy. It was expected that the work would be completed in about five years' time, if there were no political complications. At that date the labour employed was supplied by the Viceroy, and although the company paid liberally for the services of the fellaheen, the natives were practically forced to give their services in quota of about 20,000 per month. As is well known, this system was shortly afterwards abandoned, and in accordance with the result of the arbitration of the Emperor of the French, the Egyptian Viceroy, Ismail, paid the Canal Company £3,800,000 by way of compensation for the withdrawal of forced labour and other privileges granted to it by his brother Saïd Pasha. The Canal was completed by European labour, and was opened in 1870. In a note we recorded some facts recently brought to light, which pointed to James Watt having experimented in the making of photographic pictures as far back as 1791. Pictures had been discovered, one of them representing Watt's house at Soho, on the back of one of which was an inscription in his own handwriting identifying it as his production. The pictures were some on metal and some on coarse paper, and were stated by experts to be genuine photographs, although produced probably with materials altogether different from any in use in 1863. The photographs were at that date in the Patent Museum at South Kensington.

Some Recent Developments in Hardness Testing.

By EDWARD G. HERBERT, B.Sc.

A REVIEW of results obtained with the Herbert "pendulum" hardness tester* suggests that it is now necessary to attempt a preliminary analysis of the group of qualities generally comprised under the term hardness, and as this attempt involves creating new nomenclature, it seems desirable to invite discussion and criticism at an early stage in order to avoid confusion later on.

The most familiar manifestation of hardness is resistance to indentation. This quality it is proposed to call "indentation hardness." It is the hardness measured by the Brinell test and by the Herbert pendulum "time test." In each case an indentation is made by a ball and the hardness is measured by the diameter of the impression, either directly with a microscope, or indirectly by the time of swing of the pendulum, taken with a stop watch.

There is, however, one fundamental difference between the two tests. The pendulum measures the indentation while the load is on. The Brinell microscope measures it after the load has been removed.

What this difference may involve can be understood by considering an extreme case. Suppose a Brinell test is made—with suitable light load—on wax and on rubber. The test would show the wax very soft and the rubber infinitely hard, the diameter of the impression being zero. With the pendulum, tests on rubber are perfectly practicable, and accord well with results obtained with the indentation needle. It is, of course, necessary to substitute a special testing point for the 1 mm. ball.

This illustration brings us to the point that indentation hardness is of two kinds, which may exist separately, but generally are both present in proportions varying greatly with different materials. It is proposed to call them elastic indentation hardness and plastic indentation hardness.

Of these factors, the latter only is measured by the Brinell test. The pendulum measures both, but the "time test" does not distinguish between them. As, however, the behaviour of the pendulum is somewhat different on elastic and plastic substances of similar, total, indentation hardness, the latter having a greater damping effect on the oscillations, it is hoped that a means of separating them may be found by observing the amplitude of successive oscillations or otherwise.

In this connection the empirical formulæ for converting pendulum "time" hardness numbers into Brinell hardness numbers have some significance. The Brinell hardness number is a function of the area of the impression. The pendulum measures the diameter of the impression in the direction of swing, but certainly does not measure the area. It would therefore be reasonable to expect that any numerical correspondence between the two tests would exist between the "time" hardness number and the diameter of the Brinell impression or between the "time" hardness number squared and the Brinell hardness number. And this is what is actually found, but only on the plastic materials. The actual relationship is—

$$B = .3\,T^2,$$

where B is the Brinell and T the "time" hardness number.

On hardened steel, and generally on substances having a Brinell hardness number above 333, *i.e.*, on substances characterised by elasticity rather than plasticity, the square formula no longer holds, but the Brinell number is simply 10 times the "time" hardness number. In this formula the convenient factor 10 must be regarded as a pure coincidence. The time of swing of the pendulum depends on its moment of inertia, and therefore on its shape, which was designed without reference to the Brinell test.

The reason for the correspondence between the Brinell hardness number and the first power of the "time" hardness number on hard materials can only be found by working out the mathematical theory of the pendulum "time" test. This has not yet been done, but as a first step towards it the curvature of the impression is undergoing investigation.

The pendulum "scale" test is of a different order. In this test the pendulum is placed on the specimen, making an indentation, and is tilted by hand till the bubble comes to zero. The effect of tilting is to elongate the impression made by the weight of the instrument. The pendulum is then released, and in swinging under the influence of gravity, causes the ball to roll back along the groove so formed. The "scale" hardness number is the position of the bubble on the scale at the end of the first swing.

It will be seen that this test is not purely a measure of indentation. The ball is, in effect, a tool working the material. If the material is easily worked, the ball pushes a comparatively large wave of material in front of it and soon exhausts the energy of the pendulum, giving a low reading. If the material is refractory, the ball tends to roll on its surface, doing less work and therefore giving a longer swing and a higher reading. The "scale" test therefore measures "workability," or, rather, its inverse, which it is proposed to call "work hardness."

The resistance which any material offers to working with a tool depends on two factors, which all metals possess in different degrees and varying proportions. First, resistance to penetration by the tool; secondly, resistance to flow. Thus a hard steel cannot be worked because it cannot be penetrated by the tool. It has high indentation hardness. Manganese steel has low indentation hardness and is easily penetrated, but cannot be worked because of its resistance to flow. It is proposed to adopt two new terms to distinguish these qualities, viz.:—"Work hardness" or resistance to working, a composite quality consisting of (1) resistance to penetration by the tool (indentation hardness), and (2) resistance to flow, or "flow hardness."

Let S be the scale hardness number and w the work hardness which it measures; T the time hardness number and i the indentation hardness which it measures. Then if f represents flow hardness—

$$S = w = i \times f;$$

but $T = i$.

Therefore $$\frac{S}{T} = \frac{w}{i} = \frac{i \times f}{i} = f.$$

That is to say, the scale/time ratio obtained by dividing the scale hardness number by the time hardness number measures flow hardness.

To summarise the tentative theory just set forth, it seems possible to identify five distinct kinds of hardness, of which two are complex and three simple.

(1) *Compound Indentation Hardness*, measured by the pendulum time test, a composite quality, comprising

(1A) *Plastic Indentation Hardness*, measured by the Brinell test, and

(1B) *Elastic Indentation Hardness*, measured by the pendulum time test on glass, rubber and the hardest steels, but otherwise not yet isolated.

(2) *Work Hardness*, or resistance to working with a tool, measured by the pendulum scale test, a composite quality, comprising

Indentation Hardness as above, and

(2A) *Flow Hardness*, or resistance to flow, measured by the pendulum scale/time ratio.

Resistance to abrasion, though highly important, cannot be regarded as a kind of hardness. Apparently it is not an inherent property of any material, but varies with the character of the abrading body.

The significance of these relations is shown by the accompanying diagram, giving the time and scale hardness numbers of materials from pure tin to plate glass. The specimens are placed in the order of their indentation hardness, as measured by the Brinell and pendulum time tests. Brinell tests were not made on specimens 1, 2, 3, 9 and 12, for obvious reasons.

It will be seen that on hardened steels 2 to 11 the work hardness generally follows the indentation hardness, the flow hardness gradually increasing as the steel becomes softer. An important exception is the hard-drawn piano wire No. 9. This material shows a lower indentation hardness than the heat-hardened steel No. 8, but a considerably higher work hardness, due to its higher flow hardness. It might perhaps be anticipated that a material hardened by cold working would show a greater resistance to flow than one hardened by heat treatment, and this relation has generally been found. It is thought to be of great importance to have a ready means of distinguishing between the hardness produced by cold working and by heat treatment respectively, a distinction which no indentation test is capable of making.

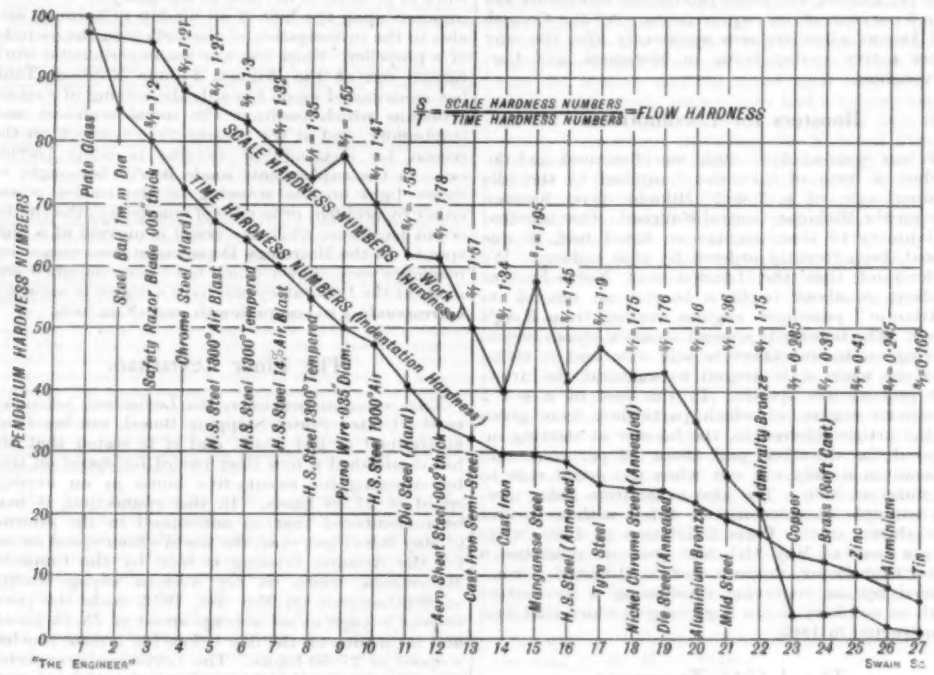
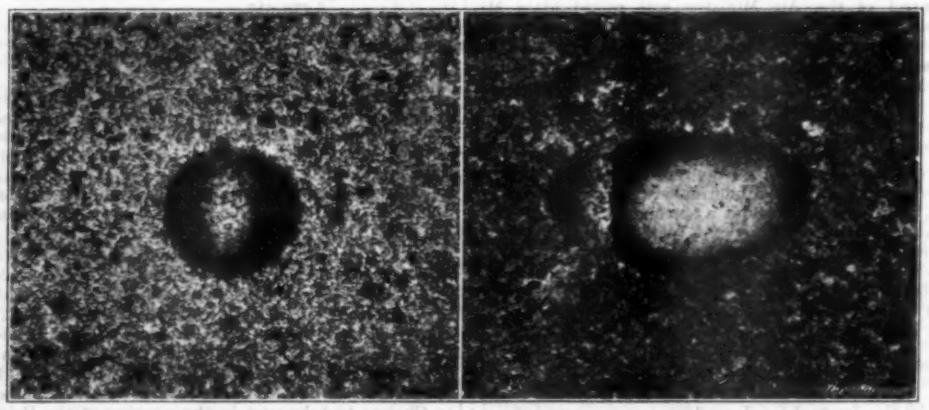


DIAGRAM OF TIME HARDNESS AND SCALE HARDNESS NUMBERS



HERBERT HARDNESS TESTER—TIME AND SCALE TEST INDENTATIONS

Manganese steel No. 15 has an indentation hardness only equal to that of soft cast iron No. 14, but owing to its exceptionally high flow hardness, its work hardness approaches that of hardened die steel No. 11. Mild steel No. 21 combines low indentation hardness with low flow hardness, and therefore has low work hardness. Copper, brass, zinc, aluminium and tin have very low work hardness figures, and this fact is seen to be due rather to their low flow hardness than to specially low indentation hardness.

An example will show the impossibility of correctly judging the hardness of a material by indentation alone. A cast steel gear blank was apparently soft—it gave a low Brinell number—but could not be cut owing to the tearing of the metal. Tested with

* Illustrated and described in THE ENGINEER for April 13th, 1923.

the pendulum, it gave the following results:—Time (indentation hardness), 22 (= Brinell 144); scale (work hardness), 42; S/T (flow hardness), 1.9, or almost equal to that of manganese steel. Owing to its low indentation hardness, it was easily penetrated by the tool, but its flow hardness was so great that a smooth cut could not be obtained.

The author wishes to acknowledge his indebtedness to Mr. Dempster Smith and Mr. I. Hey, of the Manchester College of Technology, for ungrudging assistance in the physical testing of the specimens referred to, and to the Research Department of the Metropolitan-Vickers Company, Manchester, for making microphotographs of impressions.

Increased Brake Power for Passenger and Freight Vehicles.

In the discussion at the Institution of Civil Engineers on the paper of Sir Henry Fowler and Mr. Gresley on the vacuum brake applied to long freight trains, which took place in January of last year, mention was made of a compound lever arrangement used on the bogie stock of the Midland Railway. By the courtesy of Mr. R. W. Reid, the carriage and wagon superintendent of the London, Midland and Scottish Railway Company, we are now enabled to reproduce in Fig. 1 a drawing of the arrangement as equipped to coaches of up to 30 tons tare and bogie wagons of up to 40 tons capacity, which practically gives a three-fold increase to the leverage of the vacuum brake.

It is sometimes impossible, with the vacuum brake, to obtain the necessary pressure on the brake blocks without using an unduly large, or more than one, cylinder; alternatively using a very large multiplying ratio in the levers, necessitating a constant adjustment of the brake blocks in order to prevent the piston in the brass cylinder reaching the bottom of its stroke before the full application of the brake blocks has been attained. This invention not only obviates the use of more than one cylinder, but also removes the necessity for constant brake block adjustment.

Keyed to the rocking shaft A is a lever B, the outer end, B 1, of which rests on the spring C. Lever B carries a pin D, to which is attached the slotted lever E coupled at the outer end to the rod F of the vacuum cylinder. Lever E has a pin G, which carries the pawl H, engaging with the quadrant J, the outer end of which has teeth that engage with the fixed steel rack K. Upon pawl H rests the cup head of the bolt passing through the spring C. When the vacuum is released and the piston F rises, it lifts lever E, pawl H, spring C, lever B, and quadrant J, and the brake blocks are pressed against the wheels with a leverage of 20 to 18. The teeth of the quadrant J, meshing with those on the rack K, cause the former to turn rapidly. As soon as the blocks are hard on, lever B tends to remain stationary and the further rise of piston-rod F puts the spring C under compression, so that the pawl is turned and holds the quadrant and, therefore, the lever E, so that they act together round the fulcrum L, giving a leverage of 14 to 2, which, acting on 8 to 18, produces a resultant leverage on the brake pull-rod of 3¹/₂ against a take-up leverage of 20 to 18.

This compound lever is a patented arrangement belonging to the Monarch Door Controller Co., of 7, Victoria-street, S.W. 1, to which we are indebted for an opportunity also to describe that company's "Little Giant" brake lever for high capacity freight wagons. This is a development which has arisen out of the necessity for greater hand-worked brake power on these wagons, the carrying capacity of which has increased and the tare weight has become correspondingly higher; but, as the leverage has only been increased from 21 to 1 in 8-ton, 10-ton and 12-ton wagons to 25 to 1 for 15-ton and 30 to 1 for 20-ton, the percentage of power to load has fallen from 10 per cent. in an 8-ton wagon to 7 per cent. in a 20-ton.

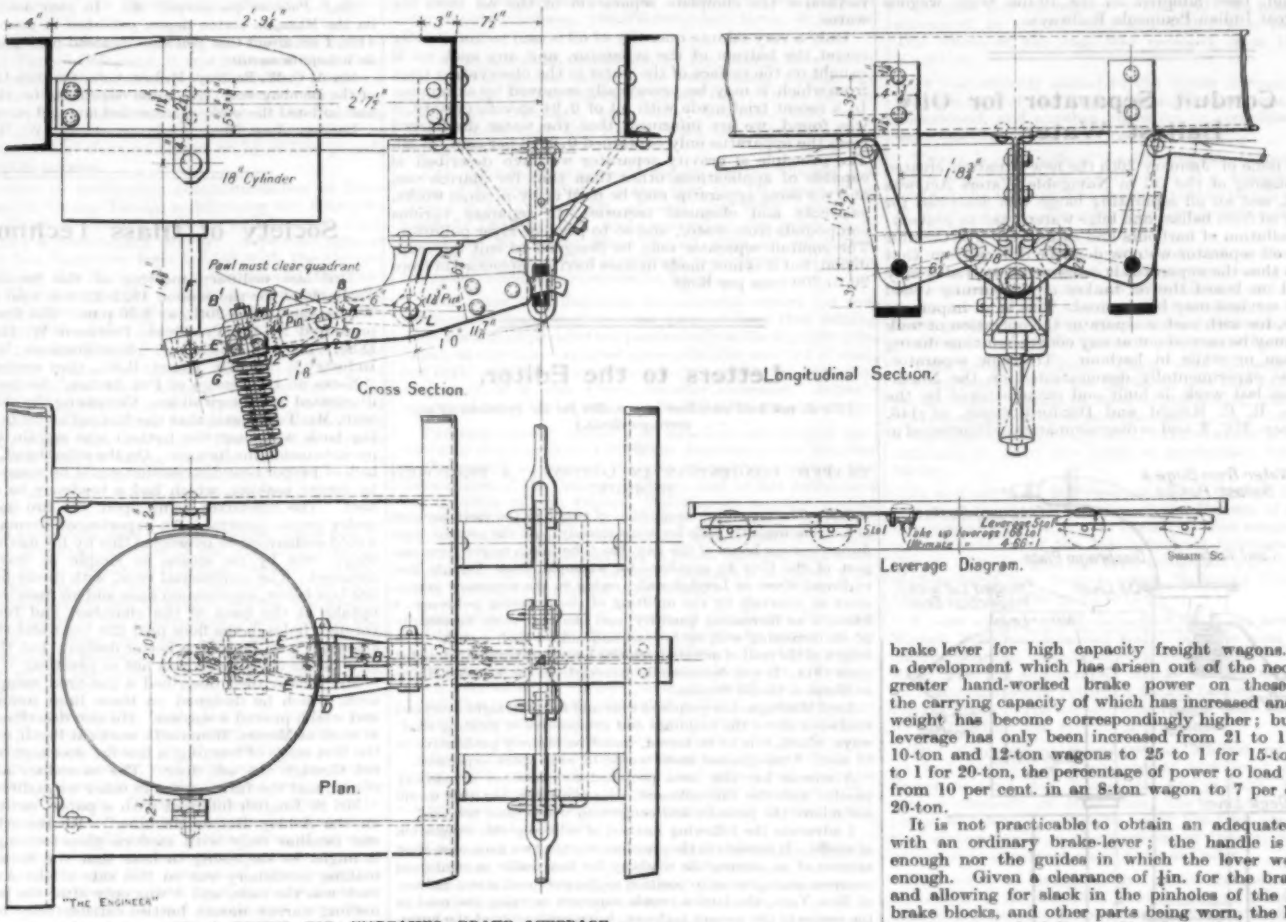
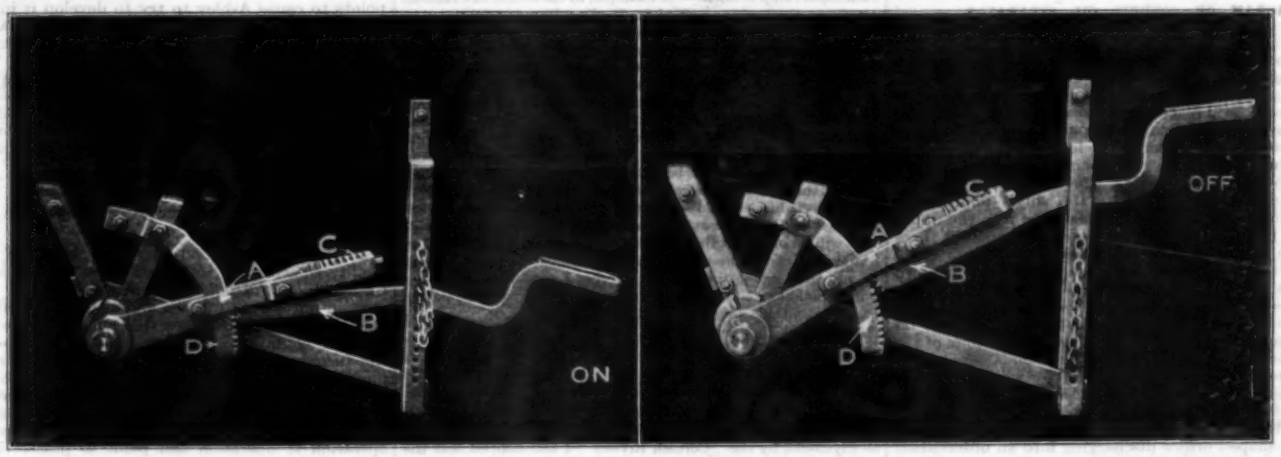


FIG. 1—DEVICE FOR INCREASING BRAKE LEVERAGE

It is not practicable to obtain an adequate leverage with an ordinary brake-lever; the handle is not long enough nor the guides in which the lever works deep enough. Given a clearance of ¼in. for the brake block, and allowing for slack in the pinholes of the lever and brake blocks, and other parts being worn, the lever may require a travel of 8in. or 9in. down the rack to obtain sufficient pressure, and if the brake rigging be loose or otherwise elastic, the lever may be at the bottom of the rack and yet not give enough pressure.

Screw brakes with hand levers have been employed to meet these deficiencies, but they have introduced a new objection, owing to the fact that to actuate the brakes the screw on one side of the wagon turns in one direction and that on the other side of the wagon in the opposite direction. Consequently, a shunter first must see whether he has to turn the screw clockwise or anti-clockwise; otherwise, in the dark, he may be releasing the brake instead of applying it. Moreover, a screw brake cannot be applied if the wagon be moving faster than a man can walk—in cars of the American type there is a braking platform—and, finally, the shunter is handicapped at night by having a hand lamp as well as his coupling pole.

The "Little Giant" compound brake lever, for which it is claimed that it meets these difficulties, is seen in Figs. 2 and 3, which are engravings reproduced from photographs, taken with Mr. Reid's permission, of the brake lever on a 30-ton timber truck. It has two members—an inner A and an outer B—held together by a ¾in. cotter pin, behind which is spring C. When, to apply the brake, the lever is released out of its catch both parts fall, naturally, to a certain point. This takes up the slack due to clearance and wear. The subsequent pressure by the shunter at a rate of 9 to 1 will then overcome the resistance of the spring C, and the teeth at the end of the member B will then engage in corresponding teeth in the rack D fixed about midway between the brake shaft and the lever guide, and serve as a fulcrum for obtaining



FIGS. 2 AND 3—THE "LITTLE GIANT" COMPOUND BRAKE LEVER FOR HEAVY WAGONS

intensified power. The second power is 6 to 1, and so there is an ultimate power of 54 to 1. The percentage of power to load is constant at about 20 per cent. An attractive feature is that the shunter has nothing to learn or to watch; his movements are the same as with an ordinary brake lever.

The "Little Giant" compound lever brake has, we understand, been adopted on the 40-ton bogie wagons of the Great Indian Peninsula Railways.

The Conduit Separator for Oily Ballast Water.

IN our issue of January 26th the new situation created by the passing of the Oil in Navigable Waters Act was discussed, and an oil separating barge was described for removing oil from ballast and bilge waters, and so preventing the pollution of harbours and estuaries. The Conduit patented oil separator we now describe differs from that system in that the apparatus is constructed so that it may be placed on board the oil tanker or oil-burning vessel where its services may be required. This is an important difference, for with such a separator the operation of tank cleaning may be carried out at any convenient time during the voyage or while in harbour. The new separator, which was experimentally demonstrated on the North-East Coast last week, is built and manufactured by the patentees, R. C. Knight and Dunford Smith, of 146, Bishopsgate, E.C. 2, and is diagrammatically illustrated in

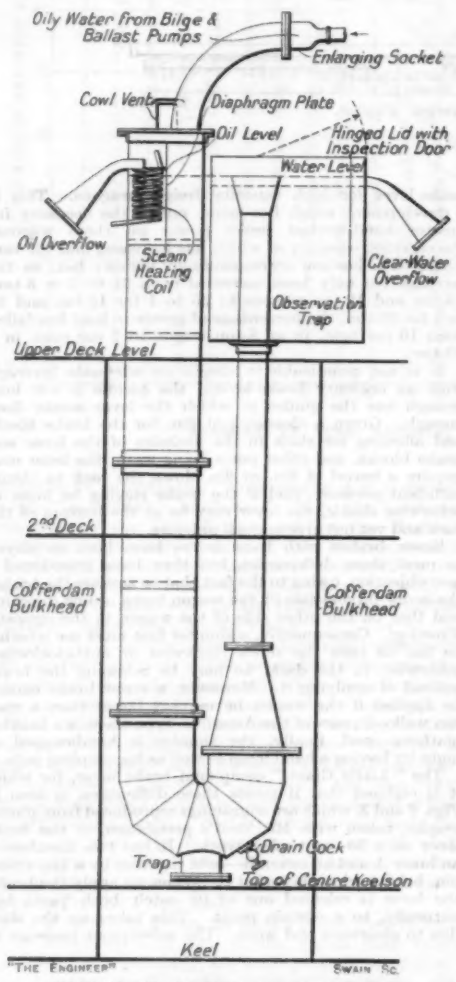


DIAGRAM OF CONDUIT OIL SEPARATOR

the accompanying drawing. As shown, the arrangement is that designed for erection in a cofferdam compartment, such as is usual for oil tankers, but the same apparatus may be equally well placed on a stokehold bulkhead.

The separator consists principally of two vertical conduits connected together at the lower end, the capacity of the conduit on the inflow side being considerably larger than that of the outflow side. The oily ballast water is delivered to the inflow side by the ship's pumps, and passes through a large diameter inlet pipe into the upper part of the first conduit. At the top of this conduit there is fitted an open-ended cowl ventilator to facilitate the escape of air and gases, and the conduit is divided into two halves by a vertical diaphragm plate. On the inner side of this plate there is a free passage for the entering water, while on the outer side a steam-heating coil and an oil overflow connection are provided. At the bottom of the column there is a trap to remove any solids which may collect there, and also a drain cock by which the level of water may be lowered to any desired position for the examination of the exterior of the conduits. The conduit on the outflow side is of smaller diameter and terminates in a funnel-shaped orifice discharging into an observation tank, which has a hinged door for inspection and is fitted with a water outflow connection. Before starting, the whole system is filled with water and oil is added to the oil side at the steam-heating coil, so that the oil level is established.

The principle upon which the separator depends for its operation is the experimentally determined fact that oil globules of a certain diameter—depending upon the specific gravity of the oil—will only travel with the downward moving water column if a certain velocity is maintained. When the velocity of the water is reduced below a predetermined limit, which reduction is obtained by employing pipes and conduits of large area, an opportunity is given for the oil globules to separate out, and rise to the region of the heating coil. The heat at this part of the apparatus reduces the viscosity of the oil and further facilitates the complete separation of the oil from the water.

Only a very minute quantity of oil is said to find its way round the bottom of the separator, and any such oil is caught on the surface of the water in the observation trap, from which it may be periodically removed by skimming. In a recent trial made with oil of 0.94 specific gravity, it was found, we are informed, that the water discharged from the apparatus only contained 0.0018 per cent. of oil. The principle of gravity separator we have described is capable of applications other than that for marine use, and the same apparatus may be used in by-product works, gasworks and chemical factories, to separate various compounds from water, and so to prevent river pollution. The conduit separator may be designed to suit any condition, but it is now made in sizes having capacities of from 20 to 200 tons per hour.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

TRAFFIC CONGESTION IN LONDON: A PROPOSED REMEDY.

SIR,—The increasing congestion of traffic in the main arteries of London urgently calls for some remedy. At the present time during certain hours of the day, the time taken to get from one part of the City to another—for example, from Temple Bar to Broad-street or London-wall—owing to the necessary arrestment at intervals by the uplifting of the directing policeman's hand, is an increasing quantity, and one that must necessarily go on increasing with each year, and indeed each month. The length of the trail of arrested vehicles has approximately doubled since 1914. It now occasionally extends from the Mansion House to Mansion House Station.

Lord Montague has proposed wide and fairly straight overhead roadways above the buildings and irrespective of existing roadways, which, it is to be feared, would be entirely prohibitive as to cost. Underground roads would be even more expensive.

A scheme has also been proposed to construct a roadway parallel with the Embankment, over the river, but this would not relieve the pressure and congestion where most required.

I advocate the following method of relieving this congestion of traffic. It consists in the erection over the two main east–west arteries of an automobile roadway for fast traffic in reinforced concrete analogous as to position to the overhead street railway of New York, the lattice trestle supports carrying the road in the centre of the present highway, being preferably of the horseshoe lattice type as at present used for tram or rail traffic over some streets of towns or cities in Germany. This system would be relatively cheap and simple, and would not in any way interfere with the traffic below in the roadway, for the supports of the horseshoes placed at intervals on each kerb would not occupy any more space than lamp standards, pillar boxes and the like at present occupy. I suggest that the northern overhead artery commences with an incline or ramp in Aldgate. The overhead road will then extend along the middle of Leadenhall-street, along Cornhill, by the Royal Exchange and the Mansion House, above the Poultry, Cheapside, Newgate-street, Holborn-viaduct, Holborn, High Holborn, New Oxford-street, Oxford-street, and descend to earth with a similar ramp at the Marble Arch. It will be observed that at each proposed end there is a wide space to permit of this incline.

The southern relief artery it is proposed to begin with a ramp in the open space at the junction of Cannon-street and King William-street. The roadway would be erected above Cannon-street, past St. Paul's on the southern side, down Ludgate-hill, along Fleet-street and the Strand, with a ramp to earth and terminate in Trafalgar-quare. The northern artery might very well have a branch commencing from the open space in Finsbury-square along Chiswell-street, Beech-street, Barbican, Long-lane, and join to the main overhead artery above Holborn-viaduct. This would relieve northern traffic, some of which, coming into the City to travel west, causes increased congestion. These overhead roadways might be 40ft. to 45ft. (varying) wide, and at intervals where a wider space permitted have an additional ramp to earth—for example, in the southern overhead artery, at the back or east of St. Paul's. Ramps might also be formed from Ludgate-circus into Farringdon-road and to New Bridge-street, one by St. Clement's Church directed toward Aldwych, and one directed south adjacent Somerset House to Waterloo Bridge. Ramps to the lower road could be made in the northern overhead artery into St. Martin's Le Grand, into Holborn-circus, into Kingsway, at Tottenham Court-road, and north and south in Regent-street, displacing the cab rank. In places such as Cornhill and Leadenhall-street the overhead roadway would have to be narrower than the width stated. The northern branch or relief artery from Finsbury-square to Holborn-viaduct would necessarily have to be somewhat narrower in Beech-street and Barbican.

It will be observed that the eastern end of the southern overhead artery commences near to London Bridge. Footways might be provided connecting to the overhead road, for the larger public buildings and business houses, to enable cars to take up or set down their passengers at these points.

London, W.C. 2, June 27th. J. D. ROOTS.

RAILWAY SPEEDS.

SIR,—I noted with interest the article on "Railway Speeds" in your issue of June 8th, 1923. On several occasions of travelling to Plymouth by the "Cornish Riviera" I had noticed that the speed was very high, so on April 16th I carried a stop watch with me. Soon after leaving London we were doing the quarter-miles in 15 sec., or thereabouts, but on a particular part of the line after Newbury, I was interested and surprised to find the time for the quarter-mile being reduced gradually to 9 sec. dead. Two or three quarter-miles were done at this speed, and then I recorded one at 8 $^{4}/_{5}$ sec., or 102.3 miles per hour.

These figures for a current service train are in exact agreement with those stated to have been recorded by Mr. Rous-Marten on a special train on the Great Western Railway in May, 1904. The travelling was also "curiously smooth."

The Admiralty, S.W. 1, June 21st. J. S. PRINGLE.

THE MAZAGON COTTON DEPOT, BOMBAY.

SIR,—*Palmam qui meruit*," &c. In your descriptive article on the Mazagon cotton depôt, published in your issue of May 11th, I am afraid that you have awarded me a *palmam* which I do not quite *meruit*.

Mr. A. C. W. Fosbery, M. Inst. C.E., the then Chief Engineer of the Bombay Port Trust, was responsible for the design and also initiated the work. I succeeded him and completed it.

Bombay, June 7th. W. H. NEILSON.

Society of Glass Technology.

THE last ordinary meeting of the Society of Glass Technology for the session 1922–23 was held in Leeds on Wednesday, June 20th, at 2.30 p.m. The first paper was presented by the President, Professor W. E. S. Turner, D.Sc., his subject being "Specifications in the Glass Industry." Mr. Th. Teisen, B.Sc., then contributed some "Notes on the Design of Pot Arches," his remarks being illustrated by lantern slides. Criticising the old type of pot arch, Mr. Teisen said that the flue outlet for burnt gases at the back wall near the bottom was certain to give cold pockets inside the furnace. On the other hand, the ensuing lack of proper heat distribution could be somewhat helped by longer soaking, which had a tendency to equalise the heat. The fire-boxes being open, the fire itself was not under proper control. An experienced fireman, however, would endeavour to overcome this by his method of firing, which was by no means so simple as was commonly assumed. The continental type, with direct-fired furnace, fire-box below, combustion flues and air flues leading to the uptake at the back of the chamber, and fumes passing through holes in the floor near the front and thence to the chimney, was, he said, a better design; but the arranging of it in the glass-house was not so practical.

Mr. Teisen then described a gas-fired recuperative pot arch, which he designed on those lines some years ago, and which proved a success. He also described a pot arch at work at Messrs. Moncrieff's works at Perth, where, during the first stage of burning, a low fire was kept on the grate, fed through the ash door. The secondary air slide was closed, and the furnace was in other ways directly fired.

Mr. S. English followed with a paper, entitled "Notes on the Ashley Bottle Machine." He remarked that to one familiar only with modern glass-forming machines, it might be surprising to hear that the home of bottle-making machinery was on this side of the Atlantic; but such was the case, and it was only after the possibility of making narrow-mouth bottles satisfactorily by machines had been proved here that such bottle-making machinery was introduced in America. The first machine to make narrow-mouth bottles at all satisfactorily was designed and built by H. M. Ashley at Ferrybridge, Yorkshire, and it came to be developed in the following way. About 1866 the postmaster at Ferrybridge, Josiah Arnall, naturally, had occasion to go to the bottle works which were situated within his district, and after seeing the way in which bottles were gathered, marvered and blown, he conceived an idea which he thought, if developed, would enable bottles to be blown by machinery. He submitted his idea to a prominent South Yorkshire bottle manufacturer, but apparently it was too crude or too revolutionary to be taken up. Nearly twenty years later, H. M. Ashley, the manager of an ironfoundry near the post office, went to live with Arnall, and there can be no doubt that Arnall discussed with Ashley his ideas concerning the possibility of blowing bottles by machinery.

As a result of such discussion, Ashley built an experimental machine in which glass was poured into an inverted mould, which was fitted with a plug to form the inside of the neck and with a movable top plunger. When a charge of glass had been placed in the mould, the sliding plunger was brought down on top of it, thus pressing it down around the fixed plug and forming the neck. Compressed air was then admitted through the plug, blowing up the bottle and at the same time raising the sliding plunger to the desired extent. Such an arrangement was very simple, and was naturally unsuccessful, but it had sufficient good points to cause Ashley to try to develop it into a useful machine. The first step in its improvement appeared to have been an appreciation of the fact that three moulds were necessary, one for forming the neck of the bottle, the second for giving a preliminary form to the main body of the glass, and the third for blowing the finished bottle. This provision of a ring mould, parison mould and blow mould was the foundation on which all Ashley's experimental machines were built, and has been incorporated in every successful machine since.

THE cheapest method of making steel of very high quality is, according to an article by Mr. B. Stoughton in *Chemical and Metallurgical Engineering*, to put liquid steel in an electric furnace and then super-refine it; but one of the worst problems still remains to be overcome, i.e., the chilling of the liquid metal when poured into the furnace. Following the preceding heat the roof and lining must be examined and repaired carefully to avoid costly troubles from these sources. As an average figure it will perhaps take 500 lb. of dolomite to repair a 25-ton furnace lining, although this figure will vary greatly from operation to operation and plant to plant. This repair work takes time and cools the furnace. The metal from the basic open hearth also cools in transit. Furthermore, its melting point is relatively high, because it must be 10 to 25 points lower in carbon than the desired final analysis of the super-refined product, to allow for carbon picked up from the carbide slag. To super-refine liquid steel takes 4 to 5 hours, including repairs to lining and charging, and a power consumption of 100 to 200 kilowatt-hours per ton of product.

Railway Matters.

VISITORS from the Sheffield Congress of the Institute of Transport to the locomotive, carriage and wagon works at Doncaster, were informed by Mr. Gresley that he was fitting a "booster" to the trailing wheels of a 4–4–2 engine.

AT the ordinary general meeting on the 20th inst. of the Channel Tunnel Company, it was indicated that if the company could get the necessary Parliamentary powers it would bore a trial tunnel under the Channel. Mr. Percy Tempest, the joint general manager elect of the Southern Railway, is the engineer to the tunnel company, and he estimates the cost of the trial tunnel at 1¾ million pounds for the English portion.

WITH a view to facilitating communications in Manchuria, Marshal Chang Tso-lin is planning the construction of the Fengtien-Hailun Railway, and has sent engineers to make a preliminary survey. A protest against this scheme has, however, been lodged with the Central Government by the Japanese, on the ground that the railway would cut across the Liaoho, the Sungari River, and the South Manchuria Railway, and, therefore, impede the business growth of this Japanese-operated line.

TWO cars left the rails on the elevated railway of the Brooklyn Rapid Transit on Monday last and fell into the street. Eight people were killed. This is the worst accident of this kind experienced in New York, as derailed vehicles usually are kept in line by the 8in. by 6in. timbers between which the rails are laid. The previous serious case of derailed vehicles falling into the street was in the summer of 1905, when a train left the line owing to excessive speed at a curve. Seven passengers were killed on that occasion.

THERE are no second-class compartments on the South-Western and Brighton sections of the Southern Railway except those in the continental trains between Victoria and Newhaven. In order to come into line with its partners the South-Eastern and Chatham section will abolish second-class, except in the continental trains, at the end of September. During the year 1921 four and a-half million second-class passengers were carried on English railways, of which one-third was on the South-Eastern and Chatham.

THE unseasonable weather of the last two months must be adding to the troubles of the railway companies, as it interferes with people going for their holidays and for picnics and pleasure parties, and with visitors to shows, races, &c. Coupled with this is the delayed arrival of the expected revival in trade. These conditions, added to the unwillingness of the men's unions to accept the companies' suggestions as to a modification in the terms of service, make the chances of any further reduction in rates most remote; in fact, some of the companies' representatives find justification for claiming that the reductions made on May 1st were not warranted, and should not have been made.

THE "Proceedings" of the Institution of Railway Signal Engineers for the year 1922 have recently been issued. The papers read and discussed cover "Signal Repeaters and Light Indicators," "Compensation of Point Rodding," "Signal Replacers," "Intermediate Block Signalling," "Location of Signals," "Token Working on Single Lines," "Rotary Block Interlocking," "Training of Maintenance Staff," and "Signal Systems on the Belgian State Railways." For those interested in signalling there is a vast amount of information in this volume, copies of which, at 10s. 6d. each, can be obtained from the hon. secretary, Mr. M. G. Tweedie, 80, Caversham-road, Reading.

As anticipated in this column on June 1st the cost of living figures have led to a further reduction of 2s. per week in the pay of those men who have not previously reached the base rate. The companies, it is pointed out, will not be able in the future to look to the sliding scale adjustment for any material reduction of wages. Fully half of the employees were on the base rates before the present adjustment, and the latest reduction will leave only a comparatively small proportion of the men above the base rates for their respective grades—rates which are not affected by the fall in the cost of living. Drivers and many of the firemen have been down to the base rates for nearly twelve months. It is estimated that the latest reduction will mean a saving to the companies of a further £2,000,000 a year in wages.

THE Forth and Clyde Railway is a line 30 miles in length, running from Stirling to Alexandria on the Dumbarton and Balloch Joint Line. It is one of the subsidiary companies scheduled to be taken over by the London and North-Eastern Railway. At one time it was quite independent, and had its own rolling stock. In 1871, when the competition between the Caledonian and the North British was at its severest, the North British took the line over on very extravagant terms. A truce was called a year or two later, and in 1875 fresh terms under a fifty year's agreement, were made with the Forth and Clyde. The line is of considerably less value now, but fortunately for the Forth and Clyde shareholders the North British agreement has two more years to run, and this has to be taken into account in settling the terms for absorption. The Railway Amalgamation Tribunal has heard the case and its decision is awaited.

THE Legislature of the State of New York has passed a somewhat drastic law. By an Act signed by the Governor on June 2nd all the railway lines in the city of New York are to be operated electrically by January 1st, 1926. Most of the roads used by passenger trains have already been converted; it is at the goods lines that the new legislation is aimed. There are, for instance, the lines of the New York Central, which come from Spuyten, Duyvil, along Riverside-drive, right in to the heart of the city. Many of these lines pass along the public street, where the third rail would be dangerous. On the other hand, overhead construction has been forbidden. The Long Island Company would have to spend thirty million dollars to change the remainder of its line to electric traction. The Baltimore and Ohio's lines in Staten Island are within the city limits, and that company will want 17 million dollars.

Notes and Memoranda.

ESTIMATES covering the whole area of Saskatchewan Province place the total amount of saw material in its forests at 7,950,000,000 board feet, made up as follows:—Spruce, 3,000,000,000; poplar, 4,000,000,000; jackpine, 800,000,000; balsam, 100,000,000; and larch, 50,000,000 feet.

ACCORDING to an estimation by Dr. George Otis Smith, the per capita coal reserve, for every man, woman and child in the United States, is 23,000 tons; Great Britain, 5000 tons; Germany, 4000 tons; Belgium, 1500 tons; France more than 800 tons; Spain less than 400 tons; Japan, 150 tons.

THE consulting engineer's report on the Pivaan coal areas of Northern Natal, states that the 7ft. seam alone, taking it to average 6ft. of coal over 8000 acres, will yield 78,720,000 tons, and, averaging the other three seams at 3ft. each, these would give an additional 118,080,000 tons. This is without making any allowance for dykes, which are common to Natal.

ACCORDING to a Japanese Government report the coal workings in many regions have gone so deep that mining costs are almost prohibitive, particularly at the Kyushu pits. Japan at one time exported a considerable amount of coal, but little now goes out of the country, while the imported coal, most of it from China, steadily increases. Japan's consumption of coal is now over 25,000,000 tons per annum.

THE coal mining industry of Brazil should receive considerable impetus from the recent decision of the Minister of Transport to favour the use of native coal on the locomotives of the Central Railway, and he has authorised the director of the Central Railway to acquire special locomotives suitable for burning this fuel. Although national coal costs approximately only one-fifth of that imported, its calorific content is much inferior, and some 68 per cent. more of the national product is required than when British or American coal is used.

ACCORDING to Mr. C. V. Sweet, of the Forest Research Institute, Dehra Dun, India, logs should be converted as soon as possible after they are felled. In other words, timber should not be allowed to season in the log. Experiments conducted in various parts of India had, he said, shown that most kinds of timber suffered severe damage if they were seasoned in the log. Timber seasoned but very slowly in the log form, so that during the long seasoning period every opportunity was given for the timber to decay, split, and crack. Before the log had had a chance to season thoroughly, it was usually damaged. The timber was never completely seasoned until it was finally converted and stacked.

MOST of the metals commonly used in solders, except magnesium, are electro-positive to aluminum, so that any metals used in making a soldered joint of aluminium act electrolytically in the presence of moisture as positive galvanic poles accelerating the corrosion of the aluminium. Magnesium cannot be utilised advantageously even though it is electro-negative to aluminium because the metal disintegrates rapidly in the presence of moisture. The American Bureau of Standards recommended that soldered joints of aluminium which are to be exposed to moisture should be protected against corrosion by paint or varnish. Various compositions of zinc-tin and zinc-tin-aluminium solders give the best results. The tensile strength of a good aluminium solder is about 7000 lb. per square inch.

THE American Bureau of Mines announces that through its investigations into (1) the reactions taking place at cerain zones in the blast-furnace, (2) the effect and elimination of sulphur in coke, and (3) the use of oxygenated or enriched blast, it hopes to reach definite conclusions which will be of considerable benefit to the iron and steel industry. The possibilities of using oxygenated blast are many, and include (1) the elimination of hot stoves; (2) the use of an excess of coke to prevent chilling and freezing; (3) the elimination of sulphur; (4) allowance of the utilisation of high-phosphorus ores; (5) improvement in Bessemerising; and (6) lower costs. A committee of ten metallurgists, chemists, and engineers, including five Bureau of Mines men, is studying this phase, and will shortly issue a preliminary statement thereon.

IT is possible, according to Mr. E. K. Smith, who read a paper on the subject before the American Foundrymen's Association, to make cutting tools of malleable cast iron. He said that a number of malleable bars were heated to various temperatures, and quenched, with the rather unexpected result that the quenched metal was extremely hard, and in many cases, had a very fine grained grey fracture, greatly resembling steel. As a practical test, a bar was roughly ground to the shape of a twist drill, then hardened. Successive samples of brass, grey iron, malleable, steel, and hard white iron were drilled with this tool. A number of hammer heads, also, were cast, hardened, finished, and supplied to carpenters' shops, dispatch departments, machine shops, and other departments where hard use was certain. After three months of hard service none of the hammers developed flaws.

SHORTAGE of water supply from a well at a railway water station in a "bad-water" district of the Western States of America led to the suggestion, according to the *Engineering News-Record*, of the use of effluent from a city septic-tank plant as feed-water for the locomotive boilers. It has been pointed out, however, by a railway water service engineer, that great caution would have to be exercised in the use of such water, since resulting damage to boilers might far exceed any saving in cost of water. It is found that many septic-tank effluents still contain organic matter, and boilers soon leak when decomposing organic matter is in the feed water. If the septic tank has done its work completely, the water would probably be safe for boiler use without further treatment, if the water is reasonably soft. But if the effluent consists of hard water, the process of softening with lime and soda ash should remove organic matter thoroughly. It was considered that such effluent might possibly be used as a last resort for boiler feed water, if always safeguarded by treatment with lime and soda ash.

Miscellanea.

THE Agent-General for the Province of Quebec reports that the province is to expend six million dollars this year on the execution of its road programme.

DURING May the imports of coal and coke into Hamburg amounted to 509,100 tons and 55,301 tons respectively. The whole of the coal was received from the United Kingdom.

IT was recently stated in the South African Assembly that the site of the Durban grain elevator was not to be abandoned, and another big effort to complete the work departmentally had been decided upon.

THERE is some talk of the Birmingham Council promoting a scheme for the construction of a waterway by the route of the Weaver Navigation Canal to the River Mersey, at Weston Point, Runcorn, and thus secure a direct outlet to the sea.

THE City of Winnipeg hydro-electric system has decided to install a steam standby plant, using two 5000-kilowatt condensing and one 1000-kilowatt non-condensing steam turbines, the steam to be furnished by three 1100 horse-power Erie City type vertical water-tube boilers, working under 240 lb. pressure per square inch.

THE Drogden Canal, which puts Copenhagen into communication with the Baltic on one side and the Sund on the other, stands in need of deepening, and dredging operations are to be undertaken shortly in order to obtain a depth of 8.50 m.—say, 27ft. 11in.—which is considered sufficient to meet the needs of navigation for the near future.

IT is announced in *Science* that Dr. George K. Burgess has been appointed Director of the Bureau of Standards in succession to Dr. S. W. Stratton, who resigned to become President of the Massachusetts Institute of Technology. Dr. Burgess has been connected with the Bureau of Standards for twenty years, becoming Chief of the Division of Metallurgy in 1913.

A NEW system of oil deflectors has been developed by Michell Bearings, Limited, which may be used with non-flooded bearings running at moderate speeds. The surplus oil is deflected and scraped off the shaft, after which the oil is automatically returned to the bearing by means of special ducts. The oil deflectors have been standardised for shafts from 1in. to 6in. in diameter.

THE Commercial Secretary at Madrid reports that oil fuel depôts and tank vessels now exist at Bilbao, Ferrol, Almeria and Barcelona, and a tank depository, with a capacity of 5000 tons, has recently been completed at Ceuta. Contracts are in hand for the construction of two tanks in the harbour of Bilbao, whilst it is proposed to construct an oil tank at Cadiz.

THE work of dredging the north channel of the St. Lawrence, at the Island of Orleans, is now going on. The idea of the Federal Government and the marine authorities is, according to *Canada*, to have this passage of navigation cleared so as to allow all classes of vessels sailing to and from the port of Quebec to proceed through the north channel as well as the south with perfect safety.

DURING the week a new patented system of separating oil from bilge water was demonstrated on the North-East Coast. The separation takes place on the principle that oil globules are only carried along with the water if a certain velocity, depending on the specific gravity of the oil, is maintained. If the velocity of a downward moving column of water is reduced below this limit, the oil readily separates out and travels in an upward direction. The apparatus is so designed that it may be housed either in a cofferdam bulkhead or fixed to the stokehold bulkhead.

IT is announced that the Glasgow Corporation has arranged with the François Cementation Company for the cementation of a short section of the double tunnel of the Glasgow District Subway Railway between the stations of Kinning Park and Cessnock, a distance of 536 yards. The estimated cost is about £6700, and the contract includes penalty and bonus clauses by means of which the payment will be decreased or increased, according to the reduction in leakage which is obtained. The time required for the cementation of this section will be about four months.

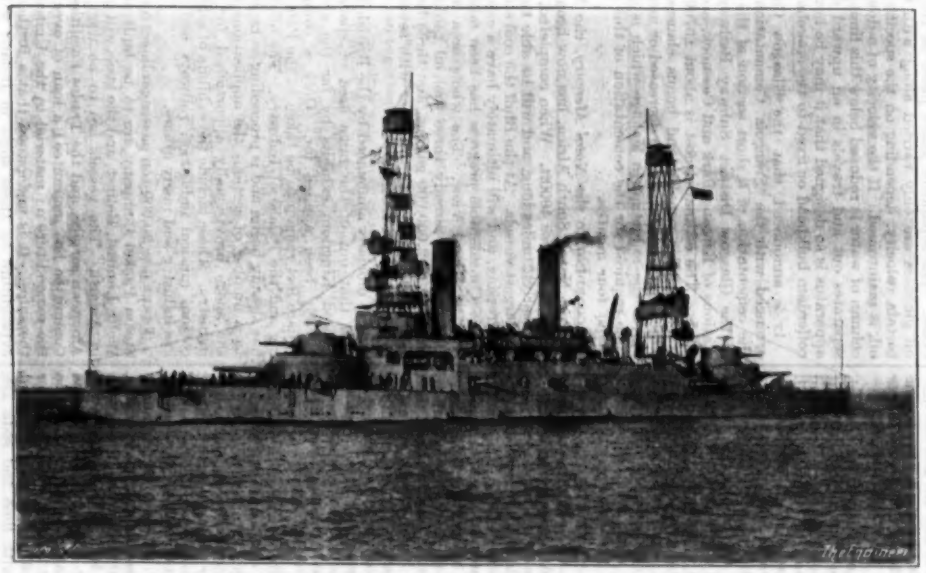
ACCORDING to the *Natal Mercury*, the Maydon Wharf at Port Natal, South Africa, has now been completed for a length of over 4000ft. When completed, the wharf will be nearly 2 miles long, and will be able to berth some of the largest vessels. At the Bluff the coal storage scheme is progressing, and will ultimately have a capacity of 60,000 tons. Considerable progress has been made with the oil sites at Island View. The whole area measures about 70 acres, and already three fuel oil tanks, each with a capacity of 2,000,000 gallons, and three benzine tanks of 1,000,000 gallons each, together with several large buildings, have been erected.

IT is officially announced by the British Empire Exhibition that out of the huge area of space available for United Kingdom exhibits by far the greater part has already been applied for. Only a comparatively few square feet remain to be taken in the Palace of Engineering and the Palace of Industry. The allotment of space has already begun and is proceeding as rapidly as possible. In a number of sections the applications already exceed the space provisionally apportioned for the particular industry. These include the exhibits of motors, chemicals, cotton, musical industries, railways and tramways, the gas industry and many others.

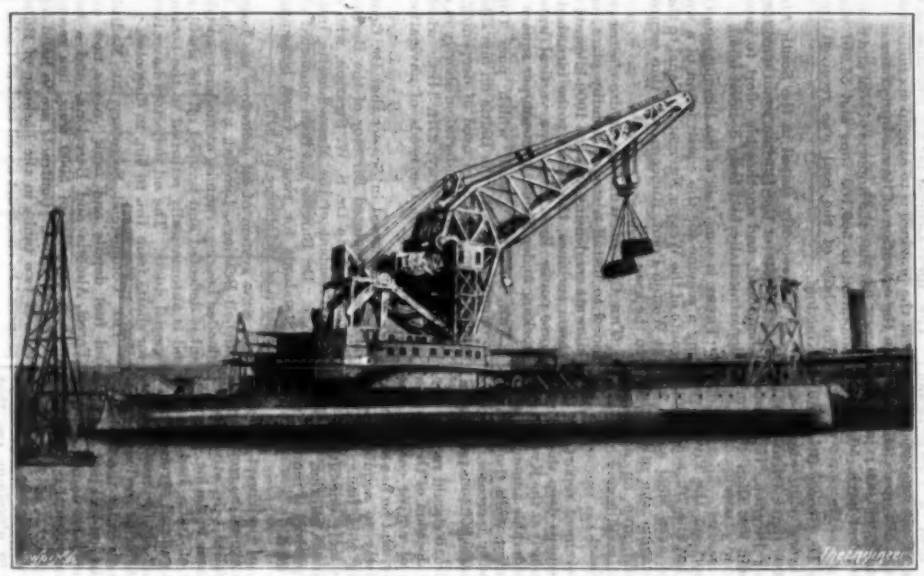
THREE new 20,000-ton passenger liners for the Royal Mail Steam Packet Company are to be built at Harland and Wolff, Limited, Belfast, and the keels will probably be laid in August. The vessels are to be used on the South American service, and the Trades Facilities Act Advisory Committee has guaranteed a loan of over £2,000,000 for the expenditure on material in the United Kingdom for the ships. It is understood that a further guarantee for expenditure on these ships in Ireland will be made by the Northern Government, which recently, under its Loans Guarantee Act, made a similar loan in connection with the 13,000-ton passenger liner Voltaire, which is to be built at Workman, Clark and Co.'s North Yard.

THE UNITED STATES NAVY CRANE KEARSARGE

(For description see page 698)

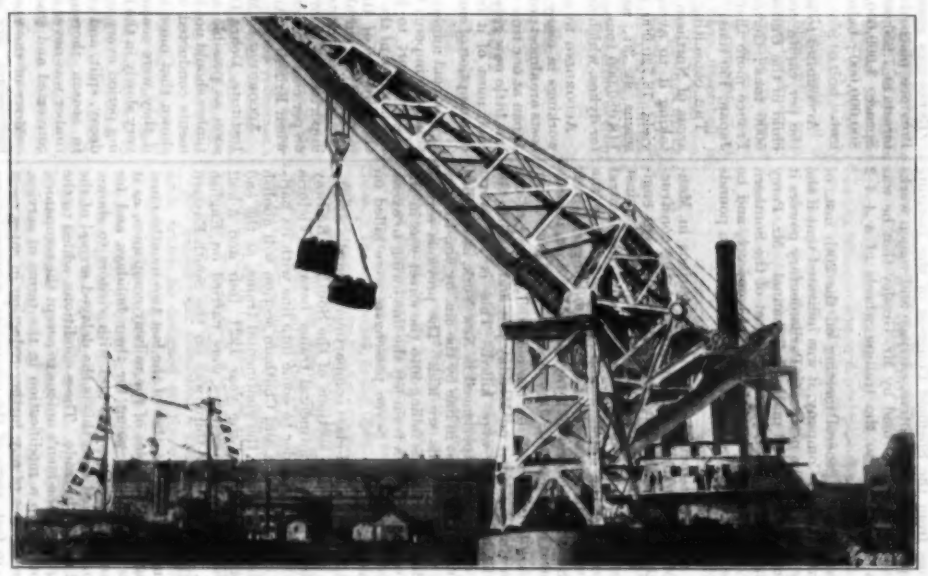


THE KEARSARGE AS A BATTLESHIP



THE KEARSARGE AS A 250-TON CRANE

LIFTING 40 TONS AT 175-FEET RADIUS



TESTING THE CRANE WITH A FULL LOAD OF 250 TONS

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THE ENGINEER.

JUNE 29, 1923.

Our Knowledge of Hardness.

FROM the date of our first acquaintanceship with Mr. E. G. Herbert's ingenious "pendulum" hardness testing device we have regarded it—and we feel sure others have shared the opinion—not only as an instrument of obvious practical utility, not merely as one more alternative to the Brinell machine or the scleroscope, but as an appliance which, when used scientifically, would probably be able to throw much needed light on some of the unsolved, fundamental problems connected with hardness in metals and materials. The theory of the instrument is as yet very imperfectly understood, at any rate from the quantitative standpoint; but practical experience is being accumulated, and from the results yielded by it, as may be gathered from the article contributed to this week's issue by Mr. Herbert himself, there is, as we anticipated would be the case, slowly emerging a new and extended knowledge regarding the elusive but very important property of hardness in materials. It must be admitted that in this respect the Brinell and other hardness testing devices have proved singularly disappointing, for after a familiarity with them extending over many years, engineers and physicists are still in the data-collecting stage in their investigations of hardness. It is true that we have now a very considerable body of exact knowledge regarding the effect on the hardness numbers recorded, of variations in the method or manner of carrying out the tests. We now know, for instance, the precise effect on the recorded hardness of varying the size of the ball and the magnitude of the load in the Brinell test, of varying the manner of measuring the indentation, of neglecting or taking into account the ridge thrown up by the indenting tool. Such knowledge, however, enables us only to obtain comparable results from test to test. As a means of shedding light on the fundamental nature of the quantity we choose to call hardness it is peculiarly ineffective. We are to-day—Mr. Herbert's investigations being excepted—no nearer a clear conception of what hardness is than we were before Reaumur first studied the subject in 1722. We have now at our disposal various refined means for measuring "hardness;" but, so little have the results obtained with these means taught us regarding the fundamental aspects of hardness, we are still unable to correlate the figure derived by one method with that obtained by another, or can only do so with hesitation by means of purely empirical formulæ having no rational basis. Mr. Herbert, on the other hand, as may be judged from his notes printed elsewhere in this issue, has at this early date already succeeded in opening up a wide field for exploration in the fundamental aspects of hardness. Whether we agree with his tentative deductions or not, we ought certainly to be grateful to him for providing a road from the barren region in which this section of physical knowledge has lingered for so long.

It may be recalled that the Herbert "pendulum" tester consists of a rocking device with a supporting ball of ruby or steel on its underside and a spirit level and scale on its upper, and that normally the centre of gravity of the whole instrument is adjusted until it is a fraction of a millimetre below the centre of the ball. With the ball resting on the material to be tested the device is set into oscillation through a very small range and the periodic time is measured. That time—or more precisely the time taken for ten complete swings—is recorded as the "pendulum time hardness number." Alternatively the device may be tilted from the horizontal through a standard angle and then released. The angle reached at the end of the immediately ensuing half-swing is read by means of the spirit level and scale and is recorded as the "scale hardness number." That the instrument can thus be used in two distinct ways, and that the results given by the two methods on a series of materials do not in general show proportionate agreement—and in some cases even reverse the sequence of the materials when arranged in ascending order of hardness—might at first sight lead us to characterise the device as even more arbitrary than any previously in use or possibly to condemn it as, self-evidently, an impossible means of measuring hardness. In the detailed description of the instrument which we gave in our issue of April 13th this year we, on the contrary, suggested that the duplicity in the method of its operation might possibly be found to be a source of strength rather than a weakness. That suggestion has been quickly verified. From Mr. Herbert's article in this issue it will be noted that he has been paying close attention to the ratio between the "scale" and "time" test figures and has found that that ratio has every indication of itself being an important practical measure of hardness. In the same article we discussed some experimental figures obtained by Mr. Herbert, and showed that they strongly suggested the existence of two separate factors influencing the figures recorded by the "time" test. These factors, in order to avoid the large issues which would have been raised by an attempt to particularise them, we referred to simply as primary and secondary hardness. Arguing from first principles, Mr. Herbert has independently reached the same conclusion, and to the two factors he gives the names plastic and elastic indentation hardness. In so doing he sheds an important light, not only on his own test, but on others, particularly the Brinell and the scleroscope tests. In the Brinell test it is clear that the indentation which is measured after the ball has been removed is not the total indentation caused by the load, but simply that portion of it which is permanent. In other words, the Brinell test is a measure of plastic indentation hardness. The scleroscope, on the other hand, would seem to be largely a means of measuring the elastic indentation hardness, for the rebound of the hammer becomes less and less as the specimen tested approaches more and more closely to the condition of a purely plastic substance. There can be little doubt that in the Herbert pendulum "time" test the period of the swing is affected both by the permanent plastic deformation and the temporary elastic indentation caused by the loaded ball, and therefore that the figure recorded for the hardness is a compound function of the Brinell and scleroscope figures. In the same manner Mr. Herbert argues that his "scale" test figure is also influenced by two factors, namely, by the compound indentation hardness as determined separately by the time test and by a property of the specimen to which he has given the name "flow hardness." This flow hardness he defines as the resistance of the metal to flow, and it is to be measured separately by the ratio of the scale test to the time test figures. Since resistance to flow in the case of a liquid or gas is determined by the viscosity, it appears that Mr. Herbert would have us recognise a corresponding property in metals, and has given us a means of measuring it. With the view that hardness, or at any rate that form of it as measured by indentation tests, is largely a matter of "solid viscosity" we cannot quarrel, for we have ourselves urged that conclusion on previous occasions.

So long as we confine ourselves to the Brinell, scleroscope and similar established tests, there is little likelihood of our knowledge regarding the fundamental aspects of hardness being extended

for the instruments used virtually define what hardness is. We cannot get beyond that definition, however we may analyse or manipulate the test results. In the end we must remain content with it and regard hardness simply as the property of materials which is measured by a hardness testing machine. In other words, so long as our measure of hardness is an arbitrary function of data derived by means of a particular type of machine, so long will we be restrained from obtaining any absolute knowledge regarding the property. It is not yet possible to say definitely that the Herbert pendulum tester is, theoretically regarded, less specialised than the Brinell machine or the scleroscope, or that the functions used as the measures of hardness in connection with it have a less arbitrary basis. It can be said, however, that it is distinguished from other hardness testing devices by the fact that it contains, not one, but at least two definitions of hardness, neither of which can be said to be more correct than the other, and that to that extent its specialisation would appear to be more than proportionately decreased. The two measures and their ratio yield three discriminants of hardness, and, taken in conjunction, the three figures for any one material do seem to have a definite and rational relationship with the characteristics associated in practice with hardness. The case of manganese steel affords a striking example of the insight into the property of hardness which the pendulum tester appears capable of giving us. Tested in the ordinary Brinell manner—and also, it is to be noted, by the pendulum "time" test—this steel shows a hardness about equal to, and sometimes less than, that exhibited by ordinary cast iron. Yet the characteristics of these two materials associated in practice with their hardness are of totally different natures. Further light on the problem cannot be obtained by means of the Brinell test. With the pendulum tester, however, we can proceed to the "scale" test, and when we do so it is found that manganese steel shows an exceptionally high "flow" hardness, a fact which is in agreement with our practical experience regarding the difficulty of machining this metal. Much additional work, both of a theoretical and experimental nature, will no doubt be required before the pendulum tester can hope to take the place of the Brinell machine or scleroscope; but from the purely scientific point of view we feel that it opens up a prospect of extending our knowledge regarding hardness such as the limitations of the existing types of testing devices would never permit us to attain.

Inland Transport.

FOR many years we have had an agitation in favour of the nationalisation and modernisation of our inland waterways, with a view to reducing the cost of heavy traffic. There is also a serious proposal to fill in the canals and convert them into roads for motor transport. It may be dismissed in a very few words. Most of our canals are very crooked. As we do not want to travel 100 miles to get to a point only 50 miles distant, the idea of converting our waterways into roadways for rapid motor transport will rarely bear examination. Arguments and figures recently given in the Press to prove what economies might be effected by this scheme are illusory. The advocates of canal modernisation point to the fine inland waterways of France and Germany, and suggest that we might have similar transport facilities. They overlook some cardinal points in the problem. British and continental conditions are vastly different. At all events, the conditions in industrial Britain are very unlike those in the canalised parts of France, Germany, Belgium, and other countries. This is a first-class railway country, as it is a first-class external shipping country; but a first-class inland water transport country it cannot be. If we spent ten times as much per mile as the French and Germans have spent on canals, we could not achieve half the results. It would almost be as reasonable to expect Switzerland to become a great shipping country as expect Britain to become a really first-rate canal country. Physical difficulties stand in the way. In the Aire and Calder Navigation we have an efficient system. But there the conditions are special. There is tidewater from Hull to Goole, and there is level country from Goole to about Castleford. In hardly any other industrial district have we such a combination of favourable natural conditions. The Manchester Ship Canal runs through level country, but it stands apart from the general problem of barge canals. Then there is the long-debated question of a ship canal across Scotland, now revived by Sir Ian Hamilton and others. It appears to be a practical proposition, both on commercial and strategical grounds.

But when it comes to the question of a general national scheme of canal development, as apart from local and special cases, the whole question takes on a different complexion. This canal problem is a matter of levels, of natural rivers, and of water supply for top levels. Continental canals owe their success chiefly to the existence of big rivers flowing through comparatively flat country. Those rivers lend themselves naturally to economical canalisation. Continental canals have been half made by Nature. They have been easy to construct. They are easily maintained. Navigation on them is easy. There are few lockages. Barges can travel long distances without encountering a lock. There is an abundance of water. In one case on the Continent there are only three locks in 200 miles of navigation. In this country we have a lock for less than two miles, on the average, and in some cases we have a dozen locks in half a dozen miles. We have hardly any natural river in this country suitable for canalisation. Practically all our rivers are short, narrow, shallow and full of weirs. Not only are we short of suitable rivers, but we are often short of water for the top levels in dry weather. If we widened and deepened the canals and tried to pass much more traffic in larger barges the loss of water downward with every boat locked up or down would be such, coupled with the altitude of the top levels, that the question of an adequate water supply for the high portions of the canals would present an almost impossible—certainly a difficult and highly expensive—engineering proposition. Not only so, but our abnormal number of lockages would render cheap and speedy navigation utterly impossible. Out of nearly 4000 miles of inland navigation in Great Britain only 1400 miles are natural or adapted river. If we brought our canals up to continental standards of width and depth, then at least nine miles in every ten would have to be artificial. In France, with their big canals, 4392 miles of navigation are natural out of a total mileage of 7006. In Germany 5815 miles are natural out of 7038 miles. In Austria 2427 miles are natural out of 2772 miles. In Russia there are 21,000 miles of natural river out of 22,000 miles of navigation. German canals which accommodate 150-ton boats only cost £6000 per mile to construct. Those which take 300-ton boats only cost £8000 per mile. But sixteen years ago it was figured out for a Royal Commission that merely to improve our canals sufficiently to take 100-ton boats would cost £28,000 per mile. It would cost £50,000 now. On our existing inland navigations the average rise or fall is no less than 10.8ft. per mile. In Germany it is only 1.49ft. per mile. This one fact destroys or discounts about 95 per cent. of the arguments and figures of our canalisation advocates.

There are cases where it would be practical to improve our canals, but as a general proposition it may be said that the bulk of the money we can afford to spend on improved inland transport facilities—and we ought to spend a great deal in the very near future—should be spent on extending and widening our railways and in making new straight roadways. With the exception of a few canals, our inland navigations are hardly worth maintaining, and they are certainly not worth extending. That it would be profitable to convert any of them into motor roads is open to the gravest question. The least costly thing is to let them fall, as they are now falling, into peaceful decay—a relic of the days when roads were too bad for traffic and before the steam engine and the rail had shown a better way.

Literature.

The Design and Construction of Dams. By EDWARD WEGMANN. New York: John Wiley and Sons, Inc. London: Chapman and Hall, Limited. Seventh Edition. 1922. 50s. net.

THE first edition of Mr. Wegmann's treatise on the design and construction of dams was published in 1888. Since then the work has been revised and enlarged in successive editions, and the information contained in the seventh edition, issued in 1922, is apparently brought up to the year 1920. Among the subjects of interest included in the new edition are a full description of the construction of the Kensico Dam, New York, which has surpassed all previous records in the rate of progress of construction; the movable dams of the New York State Barge Canal; high dams built recently in Spain, one of which, the Camarasa Dam, about 335ft. above its lowest rock foundation, is still the highest gravity dam in the world; automatic crest-gates of the hinged leaf type, some of them 88.6ft. wide by 21.6ft. high; and siphon spillways. In addition to 164 plates, the new edition contains over 240 figures in the text.

In the thirty-four years which elapsed between the publication of the first and seventh editions, the construction of storage dams, both for irrigation purposes and for domestic water supply made rapid progress. This period also saw the beginnings of the development of hydro-electric engineering in connection with which the majority of the large storage dams completed in recent years have been built. The author, in the preface to the first edition, written in 1888, sums up the position of dam construction at that date in the following words:—"The successful completion of the Furens Dam—164ft. high—in 1866 was soon followed by that of many similar structures in France, Algiers and Italy. In the United States a concrete dam—170ft. high—is being built near San Francisco; the Sodom Dam—70ft. high—has been commenced on the East Branch of the Croton River; and the Quaker-Bridge Dam, which will surpass all existing dams in height, has been designed to form an immense storage reservoir for the city of New York."

The lists which Mr. Wegmann includes in an appendix of important dam structures built since 1888 in many parts of the world, indicate the great development which has taken place in this branch of engineering.

The first portion of Mr. Wegmann's work deals adequately with the history of design and methods of calculation, and traces the development of the theory of masonry dams from the early work of De Sazilly, Delocre and Rankine up to the present time. In the descriptive portions of the book most of the well-known dams in all parts of the world are described in more or less detail. The description of the two great storage dams constructed in Spain between 1914 and 1920, the Camarasa Dam and the Talarn Dam, was written before the publication of Dr. Parshall's paper read before the Institution of Civil Engineers early in 1922, and is based on articles which appeared in a Swiss journal. The data given by Mr. Wegmann do not agree in some details with the figures contained in Dr. Parshall's paper. The smaller of these two dams is referred to by the author as the San Antonio Dam, whereas Dr. Parshall calls it the Talarn Dam. The Camarasa Dam surpasses in height any of the great American dams, the highest of which is that at Kensico, 307ft. in height above bed rock, which was completed in 1917. The depth of water behind the Kensico Dam is, however, only 150ft., as compared with 286ft. at Camarasa.

The new chapters on crest-gates and siphon spillways are very complete, and appear to bring this part of the subject up to date. A chapter is devoted to the construction of earthen dams, and numerous examples of dams constructed by the hydraulic process, now frequently adopted in the Western States of America, are fully described. The appendices include a useful bibliography which appears to be fairly complete up to the year 1920. The volume is well illustrated, and is a comprehensive and authoritative treatise.

SHORT NOTICES.

The Manufacture of Pulp and Paper. By H. N. Lee, &c. New York and London: McGraw-Hill Book Company. Price 25s. net.—This book is the third of a series of five prepared under the direction of the Joint Executive Committee on Vocational Education, representing the pulp and paper industry of the United States and Canada. The first and second volumes deal with mathematics, physics and science generally. The fourth and fifth will deal with the manufacture of paper. This volume, complete in itself, covers the preparation of wood pulp by the mechanical, sulphite, soda and sulphate processes. No less than twelve different writers have contributed to it. Although little or no wood pulp is made in this country, considerable attention is now being paid by British engineers to the machinery and plant used in its manufacture. To such engineers and, in general, to all interested in paper making, the book will undoubtedly prove of very high value, for, while paying the necessary close attention to the chemical side, it deals with the mechanical aspect of the industry very clearly and fully. It is written by experts, but its educational nature renders it suitable for study by all, no matter how well or how ill they may previously have been acquainted with the details of the pulp industry.

BOOKS RECEIVED.

The Elements of Applied Physics. By Alpheus W. Smith. London: McGraw-Hill Publishing Company, Limited, 6–8, Bouverie-street, E.C. 4. Price 12s. 6d. net.

Practical Heat. By T. Croft. London: McGraw-Hill Publishing Company, Limited, 6–8, Bouverie-street, E.C. 4. Price 25s. net.

Hydraulics Applied to Sewer Design. By G. S. Coleman. London: Crosby Lockwood and Son, Stationer's Hall-court, E.C. 4. Price 10s. 6d. net.

The Engineering of Excavation. By George B. Massey. London: Chapman and Hall, Limited, 11, Henrietta-street, Covent Garden, W.C. 2. Price 30s. net.

The Internal Combustion Engine: Vol. II., High-speed Engines. By H. R. Ricardo. London: Blackie and Son, Limited, 50, Old Bailey, E.C. 4. Price 30s. net.

How to Reform our Railways. By J. G. B. Sams. London: Selwyn and Blount, Limited, 21, York-buildings, Adelphi, W.C. 2. Price 1s. net.

French Congress on Industrial Heating.

AT the opening meeting of the Congress on Industrial Heating held at the Conservatoire des Arts et Métiers, which took place in Paris on the 4th inst., Monsieur Le Trocquer, Minister of Public Works, explained that the objects of the papers and discussions during the succeeding days was to show what progress had already been made in the economical utilisation of fuel for steam raising and to prepare for further developments, especially in the way of making better use of the poorer quality fuels which are to be found in fairly large abundance in France. Anything that will aid in reducing the huge sums paid for imported coal is regarded as of national importance, and the Commission Interministérielle d'Utilisation du Combustible, which organised the Congress with the aid of practically all the scientific and industrial associations throughout the country, has already collected and collated a vast amount of useful data and has stimulated research in a way that has completely changed the aspect of the fuel problem. Intended to be purely a national Congress, the announcement of the gathering aroused so much interest abroad that its scope had to be enlarged by the inclusion of foreign countries, Great Britain being represented by Mr. Charles Lander, of the Fuel Research Board, Professor Wheeler, Dr. Marie C. Stopes and Mr. David Brownlie, who presented communications. Altogether there were close upon eighty papers, which were grouped according to the subjects dealt with, so that there was no overlapping at the simultaneous meetings.

PULVERISED COAL.

The papers read showed the vast amount of experimental and research work being carried out in France, especially in determining the physical characteristics of fuels and ascertaining the most suitable conditions of combustion for fuels of comparatively low heat value. For that reason a great deal of attention has been given of late to pulverised coal, and while powerful electrical generating plants at collieries in the Nord are running with pulverised coal the system is now being employed by a number of steam users, as was observable in the small pulverisers and air injectors shown at the exhibition inside the Conservatoire des Arts et Métiers. Several papers were devoted to the subject, which is presenting a rather serious problem on account of the high percentage of ash in most French fuels. According to the experience of M. Roszak, the quantity of ash increases with the fineness of the coal. This he attributes to the ash passing through the screens more easily than the coal, so that there appears to be no means of grading pulverised coal with any fair degree of accuracy. The question of dealing with the ash occupied a great deal of attention, particularly with regard to the fusibility of the ash, and the problem is complicated by the fact that the ash in various coals vitrifies at different temperatures. It is hoped that a solution will be found in the experiments being carried out at Puteaux with the separation of non-volatile matter by the oil process. Of great value was the contribution of M. Audibert, who gave results of laboratory tests carried out with pulverised coal by the Houillères Centrales. During those tests it was soon found that coal dust could only give satisfactory results when the volume of the combustion chamber was in definite proportion to the quantity of coal injected, and the volume was determined by the experimental burning of coal dust in a vertical cylindrical chamber. As was to be expected, the rapidity of combustion was found to increase with the fineness of the dust, and to be unaffected by the presence of ash. Moreover, the rapidity is further augmented 15 per cent. by whirling the dust as it issues from the injector. In an apparatus shown by Messrs. Schneider et Cie. in the exhibition, this was done by injecting the dust through a cylindrical fan. It was further found necessary to increase the area of the combustion space and reduce the speed of the injection, and while certain mixtures of coal gave good results, others did not burn at all, the dividing line between success and failure being often very narrow. Although experience has shown that pulverised coal is efficient for steam raising in boilers designed for it, the temperature is, nevertheless, localised, with the result that around the injector are zones of low temperature. M. Roszak was of the opinion that pulverised coal could not supplant the grate, which produced a radiation of heat, while the heat of the flame was concentrated. He also remarked that as pulverised coal was only efficient when the combustion chamber was hot, the laying off of the boiler for a day or two meant a further loss of time when re-starting. M. Sohn, who has had a good deal of experience with pulverised coal, terminated the discussion by declaring that where good coal was procurable there could be no question of superseding the grate, and that the use of the fuel in a pulverised form could only be recommended in the case of coal of low heat value.

BRITISH CONTRIBUTIONS.

One of the meetings was devoted largely to the communications of British delegates. Dr. Lander presented a paper on the work of the Fuel Research Board; Dr. Marie C. Stopes interested the Congress with an address on the micrographic constitution of coal, illustrated with slides of transparent sections showing that "coal was not black"; Professor Wheeler contributed a paper upon the reactivity of coke, and Mr. David Brownlie sent communications upon regulations to be adopted for testing steam generators, as well as an essentially practical paper upon boilers in general, which, he affirmed, were nearly always badly installed. There was, he declared, more money to be saved in the boiler-house than in any other part of the works. The boilers should be in the hands of capable men, paid sufficiently to ensure the best results. In the discussion that followed it was remarked that a proper installation of boilers was only possible by means of a close collaboration of heat engineers with manufacturers. M. Smal, of Liége, described what had been done by a Commission appointed by the Association Belge de Standardisation to establish rules for steam raising in which a definite thickness of fuel on the grate was given as a guidance to those in charge of boilers. Full instructions for stoking boiler furnaces are contained in a guide published by the Association. The papers and the discussion showed that real progress is being made in the way of obtaining better boiler efficiencies, although much remains to be done to educate men in the technical management of steam generators. In explaining the methods adopted to secure better boiler efficiencies in the Saar collieries, M. Barré said that a great deal of trouble was experienced in keeping young men from leaving the boiler-house for the pits, where they could earn more money, and it was, therefore, proposed to specialise the work by creating classes for stokers who would be paid sufficiently good wages.

LIQUID FUELS.

Liquid fuels were only dealt with incidentally at the Congress, for the reason, probably, that they were covered completely at the Congress on Liquid Fuels last year, and for industrial purposes fuel oils had made much less headway than had been expected on account largely of the fluctuating high prices, which make it very doubtful whether there is any real economy in the system. In 1921 the Minister of Public Works gave orders that oil burners should be fitted experimentally to a number of locomotives. On the Midi nothing was done, and on the Est the trials were soon abandoned, while amongst the other companies the only one to continue the experiments, until recently, was the Paris-Orleans. Each company tried one or other of the annular and turbine types of burners, and it seemed to make little difference whether one or more burners were employed. The oils also varied in viscosity from paraffin to thick oils. On the whole, the results were satisfactory. Steam was raised in one half the time required with coal; there was an increase in power, the steam raised being one-third more than with coal; and the advantages were a facility for handling, the suppression of ashes and reduced labour. M. Leflot, who communicated results of the experiments on the P.O. locomotives, stated that oil caused a much more rapid wear of the grate than coal, unless special precautions were taken, and, where oils were used containing sulphur, there was corrosion of the plates. The economy of oil was far from being so good as it would appear to be theoretically. The advantages were more than off-set by the cost of transforming the locomotives and putting down storage tanks, and by the fluctuations in the cost of the fuel which had to be imported. The railway companies would, indeed, be at the mercy of foreign oil producers. As there was nothing to be gained by firing locomotives with oils on the French railways, the experiments were abandoned. M. Leflot gave details of runs between Paris and Tours from which it appeared that 11.4 kilos. of steam were raised by 1 kilo. of oil and 8 kilos. of steam from 1 kilo. of coal. If oil fuels are not making much headway in France for industrial heating on account, largely, of the uncertain supplies and fluctuating prices, M. Pillard gave results of experiments showing what could be done with a combination of liquid and solid fuels. By charging the grate with cinders and injecting heavy oil the simultaneous combustion left ashes that did not contain a trace of carbon. The quantity of water evaporated with 3 kilos. of cinders and 1 kilo. of oil was 15.8 litres, or 2.8 litres more than with the oil alone. Advantages claimed for the combined system for locomotives were that steam pressures could be increased much more rapidly when taking gradients; the labour of firing was reduced; smoke was consumed, the heat efficiency increased and fuel economised.

GAS FOR INDUSTRIAL HEATING.

Numerous papers were presented upon the use of gas for industrial heating, all of them giving results of tests carried out with furnaces of different kinds. At the Ougrée-Marihaye blast-furnaces in Belgium, the Eickworth rotary burners ensured automatically a perfect combustion with the Cowper apparatus, but it is evident that modifications will have to be carried out in the older types of furnaces to allow of their working to the best advantage with gas. The most serious impediment to the more general employment of gas heating is the want of suitable refractory materials capable of resisting temperatures of about 2000 deg. Cent. The contributions on refractory materials implied that while a good deal of research work is being carried out very little real advance has been made in the production of fire-bricks capable of withstanding from 1500 deg. to 1800 deg. for any length of time. Some interesting data were given of the successful employment of gases from coke ovens for heating Siemens-Martin furnaces at Ougrée-Marihaye. The gas, containing 52 per cent. of hydrogen, does not allow of an easy admixture of oxygen, so that there is a difficulty in adjusting the quantity of air necessary for combustion, and in any case it is found that the fire-bricks will not resist the effects of the hydrogen which accumulates in the upper part of the furnace. At Ougrée-Marihaye, therefore, the coke oven gas was compressed with cold air before its admission to the furnace, and the necessary quantity of hot air was added for the combustion. Parts of the furnace were water-cooled, this being found to be absolutely necessary. Consequently, furnaces heated with coke oven gas would have to be completely modified to ensure satisfactory working. The experiments showed that coke oven gas would be an extremely economical fuel for furnaces if only it were possible to procure fire-bricks of sufficient resistance.

RECUPERATION OF WASTE HEAT.

The recuperation of heat lost through the cooling of coke from the ovens has been carried out successfully at Zurich, while another installation is in operation at the gasworks at Rotterdam. The incandescent coke is charged into a closed chamber communicating with a boiler to which the gases are driven by a ventilator. The coke, on being cooled, drops through the bottom of the chamber, so that the upper part is kept constantly charged with incandescent coke. During 285 days the installation at Zurich cooled 7630 tons of coke and produced 2922 kilos. of saturated steam at 6.4 kilos. pressure. One ton of coke at a temperature of about 1058 deg. Cent., therefore, produced 395 kilos. of steam. Another phase of heat recuperation was dealt with in a communication showing the results that have been obtained over a long period by the Société John Cockerill by utilising gas engine exhaust for raising steam in boilers. It was stated that the economies realised were sufficient to pay 13 per cent. on the capital necessary for the entire power installation.

ELECTRIC BOILERS.

Prominence was also given to the advantages of electric steam generators which are employed with great success in Sweden, Canada and France, and M. Paul Bergeon, Professor at the Institut Electrotechnique at Grenoble, who has done a great deal to perfect this method of steam raising, dealt with the economies being made with steam boilers by utilising surplus current for raising steam and, in many cases, storing it in accumulators. As illustrating the variety of applications of electrically heated boilers, he stated that at the Fredet works at Brignoud, current is employed to raise steam in a shunting locomotive to a pressure of 170 lb. per square inch, and it is able to work for three or four hours until the pressure falls to about 42 lb. The current is not, of course, utilised under satisfactory conditions, but as it costs nothing the system is economical. In the opinion of Professor Bergeon electric steam generators should be employed throughout the country where surplus current is available.

CONCLUSION.

The papers and discussions on the last day of the Congress showed that research work is being carried out in every direction with more or less success for utilising all available sources of energy in the most economical manner possible, and thereby reducing the expenditure upon the purchase of foreign fuels. The Congress concluded with a meeting at which resolutions were presented summarising the discussions, insisting more particularly upon the adoption of a more accurate definition of calorific power and of a standard basis for calculation, while the greatest precision was recommended in analysis and in the carrying out of tests. The members subsequently visited a number of factories in the north and in the neighbourhood of Paris, where they were shown the methods employed for realising economies in fuel consumption.

ON March 30th there was a collision outside the Derby Station of the London, Midland and Scottish Railway Company, as to which Major Hall has recently reported. A parcels train from London to Manchester overran the signals and collided with a goods train going from Derby to the West. The driver claimed that the signals were in his favour, but from a conversation he had with some signalmen immediately after the collision, it would seem that he missed seeing the distant signal, and when he saw the outer home signal, which is 458 yards from the inner home, he accepted it as the distant. The outer home was at "clear" when the driver sighted it, and the premature clearance of the signal when the inner home and distant signals were at "danger" is one of the points on which Major Hall comments.

Institution of Mechanical Engineers.

THE summer meeting of the Institution of Mechanical Engineers opened at the Technical College, Glasgow, on Tuesday last, under the Presidency of Sir John Dewrance, when the members were welcomed by the Lord Provost, Sir Thomas Paxton, and by Dr. Mellanby, speaking for the Reception Committee. After the formal reception, the first paper taken was that on "Sugar Machinery," which, in the unavoidable absence of Lord Invernairn—the author—was presented by Mr. Chorlton. We give an abstract of it below. There was no discussion.

"SUGAR MACHINERY."

By the Right. Hon. LORD INVERNAIRN, Member.

The association between cane sugar manufacturers and engineers has been long and of continuous growth. Its importance to-day may be gathered from the progress shown by the history of the sugar industry. Developments and improvements, due to engineering, have largely increased the quantity and quality of sugar which now can be extracted from sugar cane.

In early times the machinery in use was crude, and we may take it that by 1800 it would be, on the whole, like the Gur plant now in use. As time elapsed the process of manufacture has been divided into stages. At first there were only two stages, namely, juice extraction and concentration with skimming. Now there are several stages, including the after treatment of scums, and these can be indicated most easily by naming the principal machines used, namely, mills, clarifiers or subsiders, mud subsiders, filter presses, evaporator, vacuum pans, crystallisers, centrifugals.

As only a rough survey of the progress of the industry is attempted, descriptions of plant and process are taken at intervals of twenty years, starting with 1800. The results of the survey are embodied in a table.*

The author then considers improvements in methods and machinery. The fact that, with even up-to-date machinery, over 10 per cent. of the sucrose in the cane is lost as sugar shows, he remarks, the opportunity and scope for further improvements. The reduction in the loss in mill extraction to only 5 per cent. involves the use of about 18 per cent. maceration on weight of cane; but this added water in the juice calls for extra fuel to the extent of 10 to 15 per cent. expressed as bagasse. Still more extra fuel is required with 2.5 per cent. loss in mill extraction, as the dilution of juice is in that case about 30 per cent. So far, it has been assumed that the juice is uniform in quality irrespective of the number of mill rolls employed. In reality the quality deteriorates with each additional crushing of the bagasse.

The actual amount of impurities removed by clarification is very small. As the amount of inversion of sucrose in a modern factory is very small indeed, the final molasses may be considered as the concentrated glucose and impurities in the clarified juice, together with sucrose held in solution by the water of the molasses or prevented from crystallising by the impurities. Such impurities consist of lime salts, of organic and mineral acids, and gummy matters originally in the juice, or formed by the hydration of cane fibre particles. These fibre particles are the direct consequence of the repeated crushing of the bagasse, and are so small that they escape through the finest screens used; persisting throughout all the stages of manufacture they appear in the molasses, and in the sugar, still recognisable as fibre particles, but altered somewhat through being partially dissolved away.

The elimination of these particles from the juice is perhaps the most serious problem at present before sugar manufacturers. The juice in Hawaii is more pure than that in Cuba, and the sugars made contain the same percentage of sucrose; but while the Cuban sugars are freely accepted by refiners, Hawaiian sugars are objected to partly on account of irregular-sized crystals and partly because of the trouble they cause in treatment after being dissolved. The cause of the difference may be taken practically that the cane crushing in Hawaii makes the juice to contain more fibre particles than does the less drastic treatment in Cuba. Removal of the cane particles would contribute to reduce the quantity of molasses produced by less gummy matter being formed and more sugar would crystallise. Screening of the juice has, so far, been insufficient to overcome this difficulty, and a remedy is wanted. This may perhaps be found through the application of knowledge developed in some other branch of industry.

Much has been done in the study and progress of means for separating the clarified juice or scums from the solid impurities; but the results still leave room for research by the mechanical engineer. In the usual processes of juice clarification for the manufacture of raw sugar, after the juice has been passed through finely perforated strainers, it is heated to about 212 deg. Fah. and flows into tanks where a small proportion of lime cream is stirred in, sufficient to make it slightly alkaline to litmus. Thereafter the juice is allowed to settle and the clear portion decanted to the evaporators. The remaining mud amounting to 10 or 12 per cent. of the total contains sand, particles of cane fibre, coagulated albumin, cane wax, lime salts and other impurities, and is generally reheated and pumped into filter presses to recover as much as possible of the valuable juice.

In some cases the mud is mixed with the dilute juice from the last mills, limed, heated and settled in conical tanks, so as to obtain a more concentrated mud amounting to 5 or 6 per cent. of the total juice, and this mud is returned on the bagasse intermediate carrier leading to one of the last mills, the object being to recover the contained juice and leave the solids in the bagasse.

In many factories a different procedure is employed, where the strained juice is limed cold, then pumped through heaters under pressure, so that its temperature is raised to 220 deg. to 250 deg. Fah. without ebullition. The juice is then under a pressure at least as great as that of steam at the corresponding temperature, and both temperature and pressure must be reduced before the juice can be put into the open settling tanks. The common method employed for the reduction is to pass the juice through a counter current tubular cooler, where the surplus heat is taken up by cold juice on its way to the high-temperature heater, and a loaded relief valve is used on the cooled juice outlet to let down the pressure. The advantage of the high-temperature method is that the coagulated matter is of harder or denser consistency than when low temperature is used. In both methods the mud should settle in flakes of appreciable size, but the "wire drawing" through the aperture of the relief valve so disintegrates the flakes that proper settling is hindered and the net result in both cases is practically the same, although the high-temperature method should be superior. The latest method of clarification takes the strained raw juice from the mills and passes it through continuous centrifugal machines of the decanting type, which separate and catch the sand and fine bagasse particles that have escaped through the fine strainers at the mills, also cane wax and other impurities lighter than the juice. The juice, almost completely freed from suspended solids, overflows and is conducted away for further treatment.

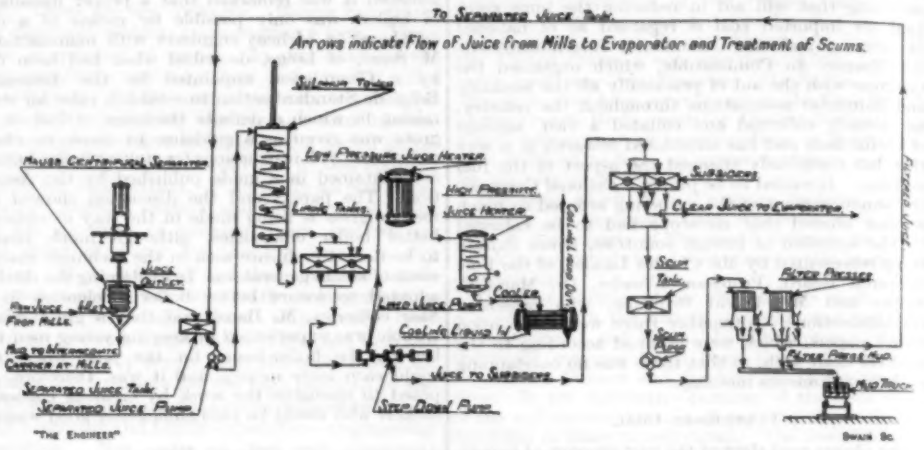


FIG. 2—FLOW SHEET OF THE MAUBS-STEWART CLARIFICATION PROCESS

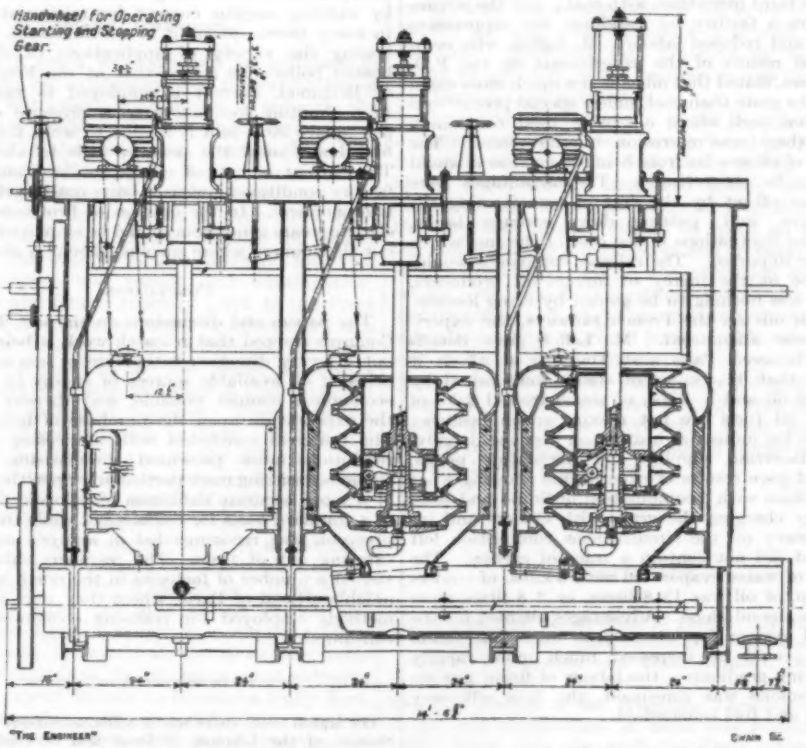


FIG. 1—MAUBS CONTINUOUS CENTRIFUGAL SEPARATOR

Fig. 1 shows the arrangement of these machines and a section of the "bucket." The "Mauss" centrifugal separator consists of a series of conical drums which revolve horizontally on a vertical spindle running on two sets of ball bearings. The spindle is hollow and contains an internal spindle which is attached at its top end to a hydraulic piston, and at the bottom end operates toggle levers to open and close the drum sections. This movement of opening and closing is controlled by a timing gear, adjustable to give the cycle of operations required for the material treated.

The machine is maintained in continuous full revolution. The liquor flows into the bottom conical drum and overflows upwards into all the conical drums. Centrifugal force moves the solids and heavier particles through the feed outwards, towards and against the periphery of the conical drums, leaving a resulting clear liquor flowing upwards and over the top lip of the drums into a suitable launder. The separation collects the solids to the quantity desired. The timing gear sets in motion the action of the toggle gear and the drums are then opened and closed. The feed is automatically cut off before opening, and the solids collected are instantly discharged by centrifugal force. At closing, the flow of feed is automatically turned on. Before opening, wash water may, if desired, be run in to displace all the clear liquor. The solids discharged from the conical drums are received in a stationary outside casing, and fall to a suitable gutter or conveyor. The machine works continuously and all operations are entirely automatic. Drive is by belt from a motor or other prime mover, the speed of the separator being from 800 to 1000 revolutions per minute.

After leaving the separator the juice is sulphured, limed, and then heated under pressure to 220 deg. to 250 deg. Fah., the heating being finished preferably by injection of steam in a heater designed after the manner of a counter-current jet condenser. In this way the highest temperature of the juice is attained very rapidly and can be kept constant without danger of overheating. The steam is supplied through a reducing valve set to give the temperature desired. On leaving the heater the juice flows through a tubular cooler with a counter current of cold juice to take up the surplus heat, so that the juice may leave the cooler at about 212 deg. Fah. The whole process is indicated on flow sheet, Fig. 2.

In ordinary clarification the mud consists of at least three portions: the sand and other heavy material, which settles very rapidly; the coagulated albumin and part of the gums in combination with the added lime, which settle slowly; and the cane wax with minute quantities of other light material, which remain floating. A small part of the impurities is of a fatty or waxlike nature and combines with part of the lime to form a soap or emulsion, and the effect of the wax and this soap is to render filtration in the presses difficult, as these matters clog the pores of the filter cloth very rapidly.

In this new method the mud consists almost entirely of the coagulated albumin with the lime salts formed during heating, and this may be treated either in the ordinary filter presses or in a new type of continuous centrifugal separator. The foreign patents for that centrifugal are not yet completed and particulars cannot at present be published.

With this system of clarification there are the following advantages:—

The fine particles of cane fibre are removed from the juice before liming or heating, so avoiding the extraction from them of gums or colouring matter. The cane wax also is removed, avoiding the troubles it would cause through emulsification or saponification.

The subsider mud is reduced in quantity and is in such

* Not reproduced.—ED. THE E.

a form that it settles rapidly, there being no oily or fatty matter present, and the comparatively large flakes formed being unbroken in handling.

In reviewing the history of cane sugar and the close relationship between the work of the engineer and the results achieved, while it is not possible, within the limits of this paper, to treat the matter in detail, the aim has been to promote, and perhaps stimulate, the interest of the engineer in an industry whose importance and value deserves his continued active co-operation.

A paper by Sir James Kemnal on "Water-tube Boilers and Crane Construction" was then taken.

WATER-TUBE BOILER AND CRANE CONSTRUCTION.

By Sir JAMES KEMNAL, Member.

THE author gives a short historical survey of the origin and progress of the water-tube boiler, pointing out that efforts were made as far back as 1796 by Count Rumford to construct a boiler separating the water into comparatively small cylinders; thereafter, improvements were suggested by John Cox Stevens, Trevithick, and others, until in 1856, the boiler was improved by Stephen Wilcox into a steam generator, which may be held to be the forerunner of the Babcock and Wilcox boiler.

References are made to early installations, some of which are still in operation. The author mentions the modifications in the materials used as improvements in metallurgical knowledge rendering such modifications possible.

Some particulars are given of the differences in circulation between semi-vertical and semi-horizontal type of water-tube boilers, and the author then discusses the advantages of water-economisers as compared with air-heaters used either singly or together in conjunction with water-tube boilers.

Considerable controversy has, he remarks, existed, alike in the application of water-tube boilers for marine purposes and for stationary purposes, over the question of whether the principle of having the tubes inclined, say, 15 deg. from the horizontal, or inclined 80 deg. to 90 deg. as in boilers called vertical tube boilers, was the better. In the former there is solid water, or as near solid as water ever is in a boiler under steam, inside the tubes on the fire side, and the steam produced inclines to the top side. In the vertical tube boiler, however, there is a geyser-like action, in which the mixture of steam and water in the tube is equal nearest the fire to what it is farthest away from the fire. In the author's experience the result with the former, as regards durability, is superior to the latter, and there is no such advantage, as is pretended for the vertical tube boiler in circulation, nor is the circulation in any way better, but, on the contrary, it is not so good. In the vertical tube boiler experience has shown that when steam is raised the lower drums, that are not exposed to the fire, are cold, thus repeating the same experience that exists with the cylindrical boiler, that when steam is raised the bottom of the boiler is cold, which condition continues until the stop valve is opened, thus setting up strains that are detrimental.

Another point that bids fair to be controversial is that of air-heaters *versus* economisers. Apparatus for slightly heating the air for combustion has been used for many years in marine work with Howden's forced draught, and recently the use of similar apparatus is extending to important stationary plants. It may be said that for stationary plants the application of both economisers and air-heaters is a considerable source of economy, and enables smaller boilers to be used for a given duty. In marine work economisers are not generally used, but the application of air-heaters is very useful.

The theories underlying the application of both these appliances are the following:—

The addition of an economiser to a boiler and superheater permits of the utilisation of a larger proportion of the heat of the fuel. The effect of a water economiser containing about 50 per cent. of the boiler surface is to increase the work done—that is, the output for a given quantity of fuel, about 8 per cent., corresponding to an increase of about six points in the efficiency percentage, bringing this up to about 82 per cent., based on the higher calorific value—or 88 per cent. on the lower value.

If an air-heater be added to a boiler in lieu of a water economiser, then to obtain the same increase of output, namely, 8 per cent., the boiler surface must be increased 8 per cent., because in the case of the air-heater the additional heat recuperated must be absorbed in the boiler surface itself. With this increased surface, and with the boilers worked at about the usual rate as when economisers are fitted, there would result about the same gas temperature at the outlet from the boiler, namely, 600 deg. to 650 deg. Fah., as with the water economiser; but if this heat has to be utilised in an air-heater, whilst retaining the same final gas temperature in the boiler, it would result in a high temperature in the air delivered to the furnace, which probably would affect the durability of the furnace material. In such cases, therefore, if an air-heater alone is to be fitted, an addition to the boiler surface is desirable, to effect a reduction in the temperature at the outlet from the boiler, so as not to raise the air temperature too high by the air-heater. This would mean a further increase in boiler surface of, roughly, 10 per cent. to 12 per cent. Hence the total increase in boiler surface if an air-heater be fitted instead of an economiser, under ordinary conditions, should be 15 per cent. to 20 per cent., and the air-heater then required would have about 130 per cent. to 150 per cent. of the boiler surface. The result would be an increase in temperature of the air to about 240 deg. or 250 deg. Fah., and an outlet gas temperature from the air-heater about the same as would be obtained from a water economiser, and the efficiency of the unit would be about the same.

In regard to fitting an air-heater in addition to an economiser with the object of obtaining a further increase of efficiency by lowering the final gas temperature leaving the unit, it may be assumed that the ordinary final escaping gas temperature from boiler and economiser is about 350 deg. to 400 deg. Fah., and if this is to be reduced by about 100 deg. the increase obtainable in efficiency would be about 2½ per cent., and the air would be correspondingly heated about 100 deg. Fah. To do this an air-heater of about 100 per cent. of the boiler surface would be required.

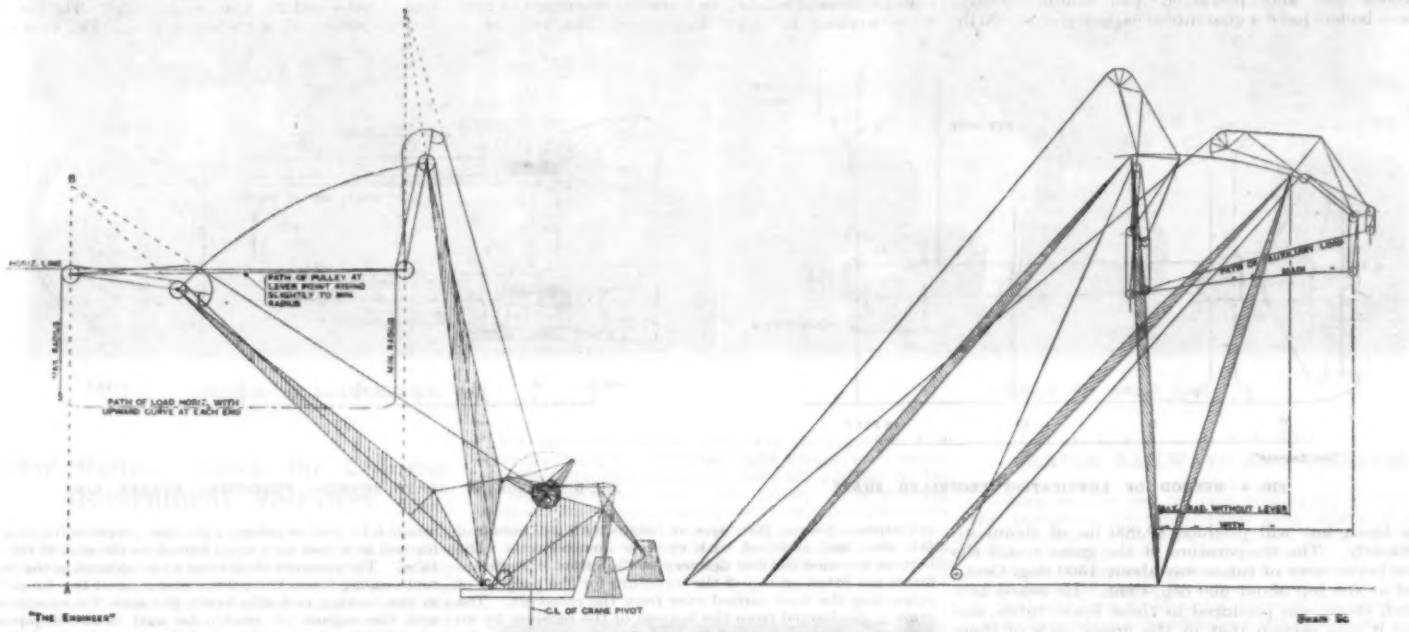
The practice is now becoming common of increasing the temperature of the feed supply by taking some of the steam from the turbine after it has passed the high-pressure stage, and passing it through steam-heaters to heat the feed-water. In such cases there is not much advantage in using a water economiser, as the work of the water economiser is done in the heaters which are used in connection with the turbine arrangements, and the high temperature at which the feed-water is supplied to the unit then does not lend itself to the effective use of the feed-water heater or economiser; in such cases the air-heater alone is preferable, the boiler surface, as stated above, being arranged so that a moderate transmission rate is provided, thus reducing the temperature of the escaping gas from the boiler to such a point that the heat which can be abstracted in the air-heater does not heat the air to more than a reasonable amount.

Passing on to the subject of cranes, the author states that a simple mechanical contrivance known as lever luffing has been largely developed during the past few years in connection with the luffing of jibs, sheers, and boats' davits. One of the first essentials to meet the requirements is to arrange the mechanism in such a manner that the jib can be luffed in or out while the load travels in a horizontal plane, or under some conditions to arrange so that the load follows some other predetermined path. For instance, when designing a rapid luffing jib-crane it might not be desirable for the load to travel in a horizontal plane, but to rise rapidly when approaching the maximum and minimum radii, so that further outward and inward movement of the jib is automatically arrested. Again, when designing sheer-legs it has been found desirable so to arrange the path of the load that while the sheers are going out the load shall rise, the objects aimed at being, first, general convenience in handling, and, second, relief of the heavy stresses in the back leg and traversing screw. Various methods have been tried to accomplish these ends, such as the well-known arrangement of the old Scotch derrick with two barrels, which can be clutched together, so that while the jib is being luffed inwards the load is automatically lowered and *vice versâ*, thus maintaining an approximately horizontal path. There are also various arrangements for passing the hoisting rope round sheaves, with the same object in view, but serious drawbacks have been discovered in all these older methods. Lever luffing meets the requirements previously stated, and a brief description follows.

The jib—Fig. 3—carries a short lever at its extreme end, over which the hoisting rope passes, the lever being pivoted on the jib head and held in position from the frame of the crane by wire ropes passing round the tail of the lever, the ropes thus automatically working the lever in any predetermined manner when the jib is luffed inwards or outwards.

It is the designing of this lever which will be of particular interest to members. In the drawing is a line indicating the horizontal path in which it is desired that the load shall travel while being luffed, the path showing an upward curve at each end which checks the momentum of the jib and prevents overluffing. To obtain the shape of the tail of the lever round which the rope passes it will be seen that a vertical line A B is drawn through the point of the lever, and another line B C through the centre of the jib. From the point of intersection of these two lines a third line B D is drawn to the point at which the back guys are attached to the frame of the crane. This forms the tangent from the fulcrum of the lever and gives one point in the path. If this operation is carried out at various points between the maximum and minimum radius the curve at the tail of the lever round which the back guy rope has to pass will be formed.

A further development in connection with lever luffing is the balancing of the weight of the jib, shown in the drawing, which is accomplished by means of a swinging weight carried on levers on the back of the revolving portion of crane and connected with the jib in such a manner that as the jib and load travel out this weight also travels out in the opposite direction and *vice versâ*. The system of balancing is a later development and is of special interest, because, in addition to balancing the jib, it counteracts the shock to the structure so prominently present when an unbalanced jib is in operation. The balancing is accomplished by a swinging weight transmitting through a system of levers its counterbalancing effect to the jib.


PATH OF PULLEY AT LEVER POINT RISING SLIGHTLY TO MIN. RADIUS
PATH OF LOAD HORIZ. WITH UPWARD CURVE AT EACH END
C.L. OF CRANE PIVOT
"THE ENGINEER"

FIGS. 3 AND 4—DIAGRAMS OF JIB CRANE AND SHEER LEGS FITTED WITH LEVER

In connection with sheer legs it will be seen from what has already been said that a lever can be fitted so that a set of sheer legs can be made to carry as heavy a load as they were originally designed for, at a far greater radius, because a large portion of the loadings can be taken by means of the guys from the lever to a concrete mooring instead of carrying it through the back leg. By making use of this idea the 100-ton sheer legs—Fig. 4—has been fitted with a lever, enabling it to carry its full load at an increased radius of 25ft., without putting additional stresses into the legs.

The latest development of this design is called the jib lever-transporter. It has the appearance of a lever jib-crane, but is so designed that the load hanging on the lever passes through the jib, so that when unloading from a ship to a point inshore the load can travel in a straight line instead of in a circle, as in the case of an ordinary jib-crane. The principles on which this transporter is designed are exactly the same as for the ordinary lever jib-crane already described, while it is counterbalanced by the same methods, but it can readily be seen that it is a far more rapid means of unloading than the ordinary jib-crane.

The principle has also been applied with success to ships' davits for large Atlantic liners. In this case there are two lever-jibs spread apart a sufficient distance to enable the boats to pass in between them, and the jib-lever operates on both sides of the vertical so that boats can be transferred from any desired point, across the ship, and lowered into the water, either to starboard or port. This has proved to be a rapid and satisfactory method of launching lifeboats at sea.

A lively discussion, which was opened by Mr. Harold Yarrow, followed. Mr. Yarrow challenged Sir James's statement that the circulation in upright tube boilers was not so good as in horizontal tube boilers. He claimed that experience at sea showed that the circulation was admirable, an evaporation of as much as 25 lb. per square foot of heating surface being attained. He dwelt also upon the disposition of the heating surface, and referred to the large area presented by boilers of the Yarrow type to the

direct radiant heat of the furnace, and he touched upon the large volume of the combustion chamber and the reduction of furnace-wall troubles, owing to the relatively low temperature of the gases reaching them. Local grooving, which had occurred with a few bottom water-drums of the D-pattern, had been entirely prevented by the adoption of the cylindrical form of water-pocket.

Mr. Patchell mentioned that in order to overcome the trouble with furnace walls, caused by high rates of combustion, water-screen walls were being employed in America. He called attention to the fact that the employment of the air-heater led to difficulties with the mechanical stokers and the brickwork owing to the high temperatures, and said that the value of the economiser as a storage of hot feed-water should not be overlooked. To his knowledge, boilers for pressures of 800 lb. to 1000 lb. per square inch were on order.

Mr. Daniel Adamson, after a few historical notes about a water-tube boiler made by his firm in 1878, discussed the arrangement of heating surface in water-tube boilers. He noted that longitudinal baffles were displacing cross baffles, and since they increased the velocity of the gases they were certainly scientifically correct. He thought more credit ought to be given to the late Dr. Nicolson for all he had done to show the value of high velocity in boilers. In his, the speaker's, opinion, flame-tube boilers gave better results than water-tube boilers when fired with waste gases, showing that it was really the difficulty of providing good combustion space that the flame-tube boiler had to contend against.

Mr. Clements gave some particulars of Babcock boilers at Parkgate which are fired with blast-furnace gas and powdered fuel simultaneously. These boilers have a guaranteed capacity of 30,000 lb. per hour, but will produce 50,000 lb. of steam indefinitely. The temperature of the gases round the four lower rows of tubes was about 1500 deg. Cent., and at the top about 600 deg. Cent. He asked how much steam was produced in these lower tubes, and said it was certain that in the upper ends of them there was no water. If circulation could be increased in them, would the efficiency be improved?

Mr. Clarkson expressed the opinion that 700 deg. Fah. was a high enough superheat, and Mr. Rushworth spoke strongly in favour of Green's economiser, whilst condemning water-tube boiler makers for trying to crowd too many things into one casing.

After Mr. Ingram had said a few words, Sir James Kemnal replied.

The meeting was then adjourned till the following morning.

For the afternoon, alternative visits had been arranged to the works at Renfrew of Babcock and Wilcox, Limited, to Messrs. Harland and Wolff's Diesel Engine Works, to the Steel Company of Scotland's Blochairn Works, and to the works of the Singer Manufacturing Company. There was also an excursion to Craigmaddie for the ladies of the party. In the evening a very well attended conversazione was held by the invitation of the Right Hon. the Lord Provost, Sir Thomas Paxton, in the City Chambers.

On Wednesday morning a paper on "Dock Appliances at Glasgow Harbour," by Mr. Daniel Fife, was first taken The following is an abstract of it:—

MODERN DOCK APPLIANCES AT GLASGOW HARBOUR.

By DANIEL FIFE, Mechanical Engineer, Clyde Navigation Trust, Glasgow, Member.

ELECTRIC COALING CRANES.

Glasgow Harbour being the home port of several large steamship companies, the vessels trading invariably take their full complement of bunker coal and load a considerable quantity of heavy material, such as boilers, machinery, &c. To provide facilities for this traffic, two 32-ton electric cranes have been installed, one travelling crane at Rothesay Dock, by Sir Wm. Arrol and Co., Limited, in 1913. An additional travelling crane, by Messrs. Babcock and Wilcox, Limited, of 35 tons capacity is at present in course of erection at North Quay, Queen's Dock.

ELECTRIC CAPSTANS.

Experience gained over the past eighteen years has shown the "Clyde" free-head capstan, 107 of which have now been installed at Glasgow Harbour, to be most efficient in service and very moderate in maintenance and repairs, especially as regards renewal of ropes.

An improved type of electrical control, supplied by the Igranic Electric Company, for large capstans has recently been installed at Glasgow Harbour. The capstan is capable of hauling a load of 15 tons at 20ft. per minute, the motor being shunt wound of 35 brake horse-power.

PNEUMATIC GRAIN ELEVATOR AT MEADOWSIDE GRANARY.

The grain intake-plant at Meadowside granary originally consisted of two movable bucket-elevators, each of 250 tons maximum capacity per hour, which are placed on the quay. It was found, after these machines had been in use for some time, that ships loaded with parcels and part cargo of grain, of which there are a considerable number discharged at Glasgow, were not economically dealt with, and that serious delays occurred owing to grain being stowed out of reach of the bucket-elevator legs.

After investigation and inspecting grain plants at various ports, the trustees decided to install at Meadowside a pneumatic elevator of 100 tons capacity per hour, the structure to be arranged to travel along the quay and traverse so that it could be placed to discharge a ship either between the two bucket-elevators or with the bucket-elevators amidships.

The structure throughout is of steel, and it is supported on a portal carriage of 20ft. wheel base. The control cabin extends outwards in front of the structure, and allows the operator a full view of the deck of the vessel and quay. The cabin contains the winch for derricking the booms and controller for travelling and jacking.

Two booms of weldless steel tubing, each 12in. diameter of bore, are connected at their inner ends to ball and socket swivel joints. The outer ends are fitted with rectangular bends and have renewable wearing plates where required. Telescopic pipes, 9in. diameter of bore tapering to 7in. diameter, are provided, and combined with the power-luffing motion of booms give a vertical movement of 25ft. when working in ships' hatchways. The receiver is cylindrical in form, 10ft. 8½in. in height with a diameter of 6ft. 3in., and is fitted with cyclone dust collector; the bottom is coned for free delivery of the grain. Duplicate filters are fitted on top of the structure for the purpose of extracting the dust carried over from the receivers. The grain is discharged from the bottom of the receiver by an oscillating tipper, motor operated, fitted with automatic closing gear and protected against damage from any solid matter being jammed between tipping-box and seating. The exhauster, which was designed and made by Reavell and Co., Limited, Ipswich, is of the three-stage rotary type in one unit, and together with the driving motor and speed increasing gear, is mounted on a common bed-plate of deep section.

The exhauster is designed for a nominal vacuum of 10in. Hg. and an aspired volume of 5200 cubic feet per minute with speed range of from 2800 to 3580 revolutions per minute; the highest vacuum obtainable being about 11½in. For the purpose of controlling the output of the exhauster at low vacuum, which occurs when the nozzles are operating in thin layers or when they are withdrawn from the grain, a system has been installed which, in actual service, gives every satisfaction. This arrangement consists of a Venturi pipe placed in the air-delivery pipe of exhauster, the throat of which is connected to a piston which is suspended by a tension spring. A spindle is carried up from the piston and engages with a rack and chain wheels which operate the shunt regulator.

DREDGING PLANT.

The author, after discussing the comparative cost of discharging grain by pneumatic and bucket elevators, then turns to the dredging plant. It is explained that the early appliances used for deepening the channel consisted of plough and rakes, which were operated by hand winches, also harrows attached to the stern of small steamers. These were used to tear up the bottom of the channel, and the current carried this material away.

An improvement on these methods was adopted at the beginning of last century by hand-dredgers, and in 1824 the first steam dredger on the river Clyde was put to work. Of this design three were built for the Clyde, two for Dublin, one for Drogheda, one for Leith, and one for Montreal, by Messrs. Claud Girdwood and Co., Glasgow. The hulls were built of wood, and the leading particulars of the vessels are as follows:—Length, 59ft. 9in.; breadth, 19ft. 10in.; depth, 18ft. 3in.; draught, 4ft. 6in.; there were twenty-two buckets, each of a capacity of 4½ cubic feet, and capable of dredging at a depth of 12ft. below water level with the ladder at an angle of 36 deg.

Gradual progress was made in the design of the dredging plant, and six machines of the double-ladder type were constructed between the years 1851 and 1860, when No. 7 dredger was built by A. and J. Inglis, the general design of which was very similar to the earlier dredgers, the chief departures being that the hull, framing and bucket-ladder were made of iron, and the winches were operated from the main engine. In 1865, No. 8 dredger was constructed by A. and J. Inglis. The design of this vessel was a departure from the previous types inasmuch as the framing supporting the ladder was brought in from the end of the vessel, nearer amidships, and the shoot for discharging the spoil was arranged so that the hopper barges could be loaded alongside. All the foregoing dredgers have been out of service since 1906, and the present plant consists of the following barge loading dredgers:—The Cairndhu, built in 1892; the Craigiehall, built in 1904; the Shieldhill, built in 1906; and the Rosslyn, built in 1912.

HOPPER BARGES.

As the deepening of the river proceeded it was found necessary to employ a more efficient plant to dispose of the dredgings than the wood flats then employed, and in the year 1862 William Simons and Co., Limited, Renfrew, designed and constructed what is generally recognised as the first sea-going hopper barge, which was capable of carrying about 300 tons. This enabled the dredgings to be deposited at a deep part of the estuary of the river, about 27 miles from Glasgow, at a greatly reduced cost. Several features in the design of this vessel are still retained in hopper barges recently constructed. Hydraulic gear was employed for operating the hopper doors. Of recent years the depositing ground has been altered to 40 miles from Glasgow, and the later barges are each capable of carrying 1200 tons of sand.

One feature of the latest type of barge, four of which were built by Lobnitz and Co., Limited, in 1911, is the method employed to preserve and lubricate the propeller shafts, which appliance—Fig. 5—has greatly reduced the maintenance charges, and enabled the vessels to be more fully employed. The tail-shafts, 8in. diameter of body, are without liners, but swelled at ends in way of bearings to 9in. in diameter, and the bushes of stern tubes are 4ft. long at outer and 2ft. long at inner end. The protecting device consists of a rubber ring—see Fig. 6—which is

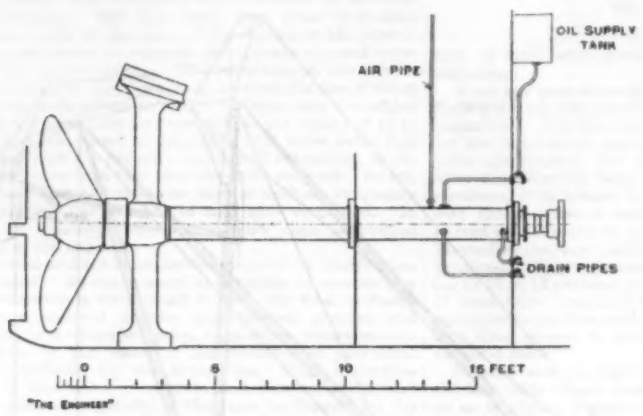


FIG. 5—METHOD OF LUBRICATING PROPELLER SHAFT

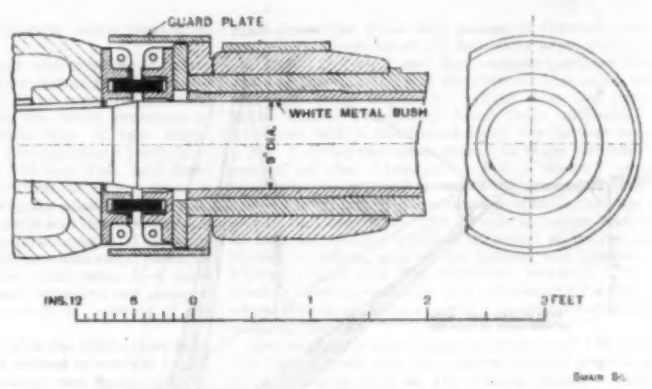


FIG. 6—SECTION OF SHAFT SHOWING PROTECTING RUBBER RING

secured to and revolves with the propeller in a groove formed in a cast iron ring, bolted to the end of the stern tube. The pressure of oil from a tank placed in the engine-room casing forces the rubber ring against the brass bush in the casting and effectively prevents the escape of oil and the ingress of sand. Air and draw-off pipes are provided for the circulation of the oil, and a steel shield is fitted to protect the rubber ring. The whole of the shaft from the propeller nut to the gland in the engine-room is under oil pressure, and so effectively protected and lubricated, that in a propeller shaft recently drawn after ten years' service, when the vessel had run a distance of 160,000 miles, no signs of deterioration could be seen.

Mr. W. Reavell opened a brief discussion on the paper and dealt particularly with the air control system employed in the latest suction grain elevators.

Mr. Bentham, of Henry Simons, also said a few words, in which he drew the members' attention to the fact that the lower part of the performance diagram—Fig. 10 of the original paper—is very rarely met with, the rate of discharge per horse-power being generally much greater.

After Mr. Fife had acknowledged the vote of thanks which was heartily accorded to a really excellent paper, Mr. Bruce Ball, of Glenfield and Kennedy's, presented a paper on "Mechanical Contrivances in connection with the Storage and Distribution of Water."

There was no discussion upon it, but Mr. Richard Allen said a few words about the control of the Nile, mentioning particularly the ingenious device of an engineer who, to save himself the trouble of visiting the nilometer every morning, had fixed a kind of gramophone to a telephone, so that he could "ring up the Nile" whenever he wanted. When Mr. Allen listened, he heard the gramophone repeating over and over again: "Five metres, five metres, five metres."

Professor Mellanby then gave in abstract a paper on "Clyde Marine Oil Engines," but the President announced that it would be taken again in London at the earliest possible moment and be fully discussed there. We propose to print abstracts of the last two papers in future issues.

Thus the "literary" part of the meeting came to an end, and the rest of the week was devoted to visits of instruction and visits of pleasure. It was an exceptionally successful summer meeting, and the attendance was large.

AMERICAN COACHES FOR THE TIENTSIN-PUKOW RAILWAY

FIRST-CLASS DINING CAR

FIRST-CLASS SLEEPING CAR

INTERIOR OF DRAWING-ROOM CAR

INTERIOR OF DINING CAR

New Rolling Stock for Chinese Government Railways.

MUCH has been written recently about the inability of the Chinese Government to pay for rolling stock which is so urgently needed on several of the railways. In July, 1921, an order was placed through Messrs. William Forbes and Co., of Tientsin, for five modern *de luxe* semi-steel passenger trains. The equipment was built under a joint contract by the Pressed Steel Car Company, and the American Car and Foundry Company, of New York. This was about the last important rolling stock contract that was made by the Chinese Government, and the equipment is certainly the finest that has been imported into this country. One might even go so far as to say that it is far too luxurious for China, and was certainly too expensive considering the financial condition of the country. Each train consists of one baggage car, postal car, dining car, drawing-room car and two each first, second and third-class coupé sleeping cars. Three semi-steel private cars were also called for under this contract. The total cost of the five complete trains of ten carriages each and the three private cars, amounted to gold dollars 2,569,843. These trains are for the exclusive use of the Pekin-Pukow run *viâ* Tientsin, and are the property of the Tientsin-Pukow Railway.

The floors in all first-class cars are covered with good Wilton carpets, whilst the halls, toilets and vestibule floors are carried out in red and green square rubber tiles. The upholstery in the first-class coupés and dining cars is in brown Spanish leather, whilst the drawing-room is in green short nap figured plush. Fabricoid is used for the second and third-class sleepers.

The ventilation is of the exhaust type by means of torpedo roof ventilators. Air intake ventilators are also provided at the bottom of the windows in first and second-class cars. Heating is on the Gould vapour system, with independent control for the coupés of first and second-class sleeping cars. The steam from the locomotive is regulated by an automatic device so that there is no pressure in the pipes inside the cars.

The exterior of the cars is royal blue with gold ornamentation and lettering in English and Chinese.

The lighting equipment is the Stone 24-volt system with Tonum batteries. All materials for the lighting were supplied by J. Stone and Co., Limited. Air brakes are of the Westinghouse type, with two shoes acting on each wheel.

Some of the special features in these cars include permanent sliding window screens; hot as well as cold running water in the wash-basins of first-class cars; brake slack adjusters for automatically maintaining a constant air brake piston travel; metal conduit system for wiring; air train signal allowing of signalling the engine driver from any car in cases of emergency; solid rolled steel wheels; roller side bearings between body and bogies, and pivoted head spring centring couplers.

The first-class sleeping cars have accommodation for sixteen passengers. There are eight coupés, each accommodating two passengers, and there are quarters for two car attendants and two toilet rooms. The drawing-room car has accommodation for twenty-four passengers, as well as quarters for two attendants and a toilet room. It is equipped with sixteen revolving parlour chairs, and has four coupés exactly the same as those in the sleepers. The dining saloon can accommodate thirty-six persons at one time, there being six tables for four persons each on one side, and six for two persons each on the opposite side. The tables are removable, and are covered with a milk-coloured glass.

FIRST-CLASS COUPE—UPPER BERTH CLOSED

On arrival in China the sections and parts were assembled at the Tientsin-Pukow shops at Puchen, under the direction of Mr. John Alston, locomotive and works superintendent of the line.

CANTON RAILWAYS AND WHARVES.

THERE are now two railways running out of Canton—the completed Canton-Kowloon line, which provides communication with Hong Kong, and the northern line which is being pushed forward to Hankow. The Canton termini of these two railways are a considerable distance apart, with the result that goods passing from one line to the other have to be carted through the town, which naturally involves a considerable waste of time and money.

Commenting on the proposals to connect the two railways by a line girdling the city, a writer in the *Journal* of the Shanghai British Chamber of Commerce says: "A fear seems to exist that the junction of the two present lines will mean a loss of business to Canton. This is impossible. The bulk of the goods coming in from the north will be for Canton, the great consuming centre, manufacturing and distributing city for the Delta; and the girdle line will facilitate distribution to local points without change of conveyance. What about Hong Kong the critic exclaims! Owing to the cheapness of water-borne carriage the bulk of the produce arriving by rail will be loaded at Wongsha on to junk or steamer. Perishable articles, very valuable goods, and to some small extent coal, metals, and stone, for cement works, from the northern line will be carried through direct to Hong Kong. But Canton will become the coal market of the province and Wongsha its chief distributing station. In place of the Fish Market rafts now obstructing the fairway and preventing bund and wharf construction, there will be good wharves and jetties to serve vessels of all kinds. To facilitate the coaling of vessels lying in the Hong Kong harbour it is certain that coal junks or lighters, loading at Wongsha coal yards, will do a good trade.

"What about Whampoa another critic exclaims. Whenever the development of a sub-port at Whampoa takes place the Kowloon rail line is at hand to assist in its development. It runs but a few miles from the present proposed site, and the laying of these few miles will place the port, its wharves and its shipping in immediate through and rapid connection with Canton itself; and by means of the girdle line with the hinterland of the province and the great cities that lie along the northern railway. A facility that can be offered by no other reasonable or economical project.

"It is a universal experience that where communications are provided and facilities offered there an increase of trade results; and with an increase in the movement of goods there is an advance in revenue collection: as freight and as duty."

FROM Vancouver it is announced that special instructions have been issued to the Geological Survey parties in British Columbia to investigate the reported discoveries of arsenical deposits in the Hazelton district.

The Kearsarge Crane.

DURING the past few years several warships have been transformed for new and peaceful services, so that they have become practically unrecognisable; but one of the most striking conversions which has come to our notice is that of the United States battleship Kearsarge into a floating crane. This change has, we believe, resulted in the provision of the most powerful sea-going crane afloat, and certainly has turned an obsolete war vessel into a most useful adjunct to the American navy yards.

The Kearsarge, together with her sister ship, the Kentucky, was built by the Newport News Shipbuilding and Dry Dock Company and was launched early in 1898. A description of the vessel appeared in THE ENGINEER of September 29th, 1894, while on January 26th, 1900, we published as a Supplement some drawings showing her internal construction. She had a displacement of 11,525 tons on a water line of 368ft. by 72ft. 2½in. beam, and was propelled by twin-screw triple-expansion engines at a speed of 16 knots.

It was decided to convert this old battleship into a crane capable of lifting a load of 250 tons and able to go out to sea. The work of altering the hull to suit the new service was undertaken by the Navy Department, while the construction of the crane itself was entrusted to the Wellman-Seaver-Morgan Company, of Cleveland, Ohio. The change in the appearance of the vessel which has been produced is plainly shown in the engravings given on page 690, for which, as well as for the other engravings used to illustrate this article, we are indebted to the monthly *Journal* published by the American Society of Mechanical Engineers. In this connection it is noteworthy that the trellis masts seen in one of the engravings were added after our picture of September 29th, 1899, was drawn.

The alterations to the hull necessitated by the change comprised extensive strengthening of the decks and framing and the addition of bulges to increase the stability, which have made the beam now 92ft. The displacement, however, has been reduced to 10,350 tons. The strengthening of the hull was effected by welding together electrically all the deck plating, so that it forms practically a continuous plate. Columns and gusset plates were also added where necessary, and the riveting of angles to plates was reinforced by welding. Some of the boilers and one of the main engines were removed, but we have no information as to whether the remaining engine drives its original screw or works a central propeller.

The crane, it will be seen, is of the luffing jib type and is capable of lifting a load of 250 tons at a speed of 6ft. per minute and at a radius of 101ft., while an auxiliary hoist for 40 tons can reach out 175ft. and has a speed of 15ft. per minute. It takes nine minutes to revolve the crane through one revolution and twenty-five minutes to luff from one extreme to the other.

One of the most difficult problems in designing the crane was the transfer of its weight to the hull, as the latter cannot be considered as a rigid base and an enormous load had to be carried. It was therefore decided to have a double-ring track on the deck and to share the load between the running wheels, as far as possible, by means of equalising beams.

The foundation is formed by a circular box girder, with webs spaced 4ft. apart, of 60ft. mean diameter, built into the hull. On the top of this girder there are four concentric rings of rails, with a rack between as shown in Fig. 2. The rails are laid in chairs with wedges beneath, so that they may be adjusted exactly level. In the middle of the ring there is a post to centre the crane. The foundation for the rotating part of the crane is best shown in Fig. 3. It comprises two box girders 10ft. deep by 75ft. long, with the webs spaced 30in. apart. These girders are braced together and are supported at their ends by the main carrying bogies. Auxiliary girders are built out from the sides and are equipped with bogies to ensure lateral stability. Between the main girders at the back there is a compartment for the counterweight, which consists of some 450 tons of old armour plate.

The construction of the jib is so obvious in Fig. 1 that it is unnecessary to enlarge upon it here, but the luffing gear is rather unusual and noteworthy. Luffing is effected by two big screws, which tie the jib back to the back stay. These two screws, which are each 83ft. long by 15in. in diameter, have right and left-handed threads at opposite ends. Appropriate nuts are secured by trunnions in the heel of the jib and in the back stay. At the centre of the length of the screws there are large bevel gear wheels that mesh with bevel pinions on a cross shaft. The driving motors are connected with this cross shaft through multiple reduction gearing. On referring to Fig. 3 it will be noticed that there is a strut pivoted to the centre of the luffing screws and also to the back leg of the jib halfway between the upper nut and the main pivot of the jib. The proportions of the several parts are such that this strut always maintains the same angle to the horizontal, regardless of the extent to which the jib is luffed, and it is thus used as a base on which to build the platform for the luffing gear. The same platform also accommodates the gear for moving the auxiliary hoisting crab in and out on the jib.

The main hoisting machinery comprises two units, each of 125 tons capacity, with drums 7ft. 2in. in diameter by 8ft. 4in. long. There are two hoisting tackles, and when the maximum load has to be lifted they are connected together by an equalising beam on the fall blocks, while the drives for the two drums are coupled by a clutch. This machinery, together with the auxiliary winch, is mounted on the side of the main turntable. The turning gear, which drives a pinion engaging with the rack between the circular tracks, is also arranged in the same machinery house, while high up above it there is the operator's cabin.

Elaborate arrangements have been made for securing the crane when the ship goes to sea. The jib is then lowered so that its head rests on a trestle at the stern, plainly shown in Fig. 2, to which it is clamped down. The weight is then taken off the turntable wheels by screw jacks arranged between each pair, and four massive turnbuckles are used to tie the turntable down to the deck. Finally, a big steel pin is pushed up from the deck into a socket in the carriage to prevent any possible turning. When everything is snugged down the crane ship can go to sea at a speed of 11 knots.

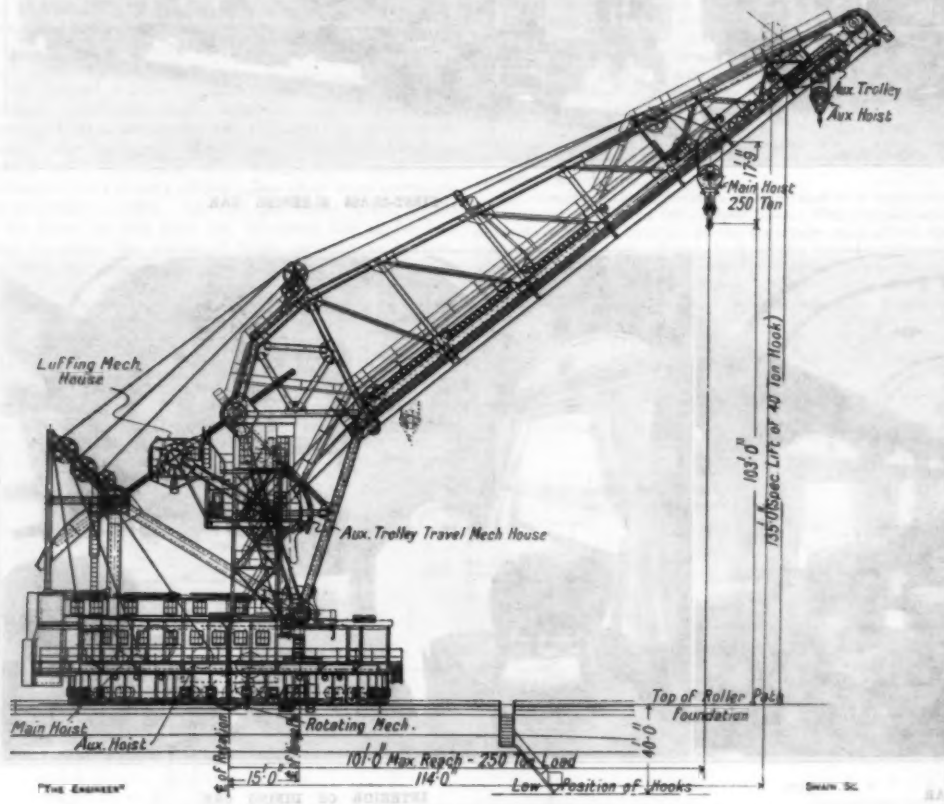


FIG. 1—GENERAL ARRANGEMENT OF KEARSARGE CRANE

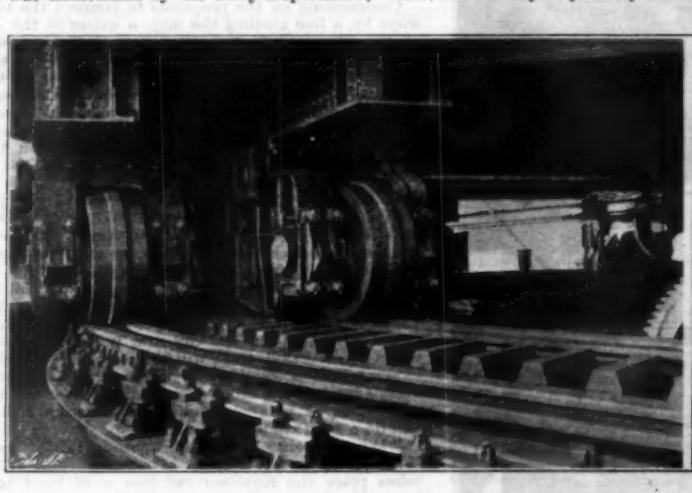


FIG. 2—DOUBLE CIRCULAR TRACKS FOR CARRYING CRANE

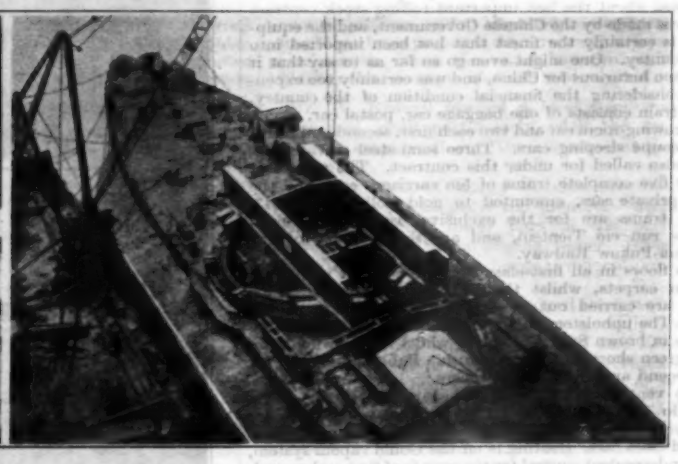


FIG. 3—BIRD'S-EYE VIEW OF SHIP AND CRANE FOUNDATION

THE TIDES FROM AN ENGINEER'S STANDPOINT.*

THE view suggested in the paper is that the idea of a tide-wave is misleading, and that it is simpler to think of the tides as being due to horizontal movements generated by the tide-raising forces in the deep water of the ocean. These movements are intensified in the shoal water round the coasts, and become the well-known tidal streams.

The rise of tide is due to obstruction of this motion, kinetic energy being converted into potential energy. The range of tide depends upon the degree to which the flow is opposed; where strong currents exist the rise is comparatively small. Where a particular component of the tidal motion meets no obstruction, it causes no rise, so that, if the coast runs north and south, there will be no diurnal inequality, while on a coast running east and west one-day tides will be found.

The ebb tide due to the reconversion of the potential energy into motion is independent of the tide-raising forces and depends on geographical conditions, the streams taking the directions which give the quickest escape to the banked-up water. In a deep gulf the ebb will be in the reverse direction to the flood, but on an open coast which the flood strikes obliquely the ebb will be more or less in the same direction, resulting in a littoral current. In consequence of the ebb being independent of the tide raising forces, its total energy must be less than that of the flood by the energy lost in friction. The mean sea-level towards the end of a long inlet, in consequence, will be higher than at its mouth, and half-tide level will be higher at springs than at neaps; the ebb will also last longer than the flood.

In long gulfs an oscillation of the whole body of water

* Official abstract of a paper by Mr. Edward William Hollingworth, M. Inst. C.E., to be brought forward for discussion at the Institution of Civil Engineers.

estuary, instead of across it, the material is deposited in banks lying up and down stream and eventually forms a delta. The tendency of the drifting material is to move towards the heads of all inlets, where large deposits are found; these are capable of reclamation if sufficient silt is supplied by adjacent rivers.

A survey of the present condition of ancient ports reveals the greatness of the changes which have taken place in the coast-lines during a comparatively short period, and which can be traced to the influence of the flood-tide.

THE OPTICAL SOCIETY.

AT a meeting of the Optical Society, held on Thursday, the 14th inst., the first paper to be read and discussed was "Levels and Level Bubbles," by S. G. Starling. The paper dealt with the factors affecting the efficiency of levels of the bubble form. The results were given of measurements of the density, surface tension, and viscosity of several liquids, *e.g.*, benzol, xylol, chloroform, alcohol and ether, which are used in levels and the corresponding measurements on petroleum ethers distilled at various ranges of temperature, the ether distilled at 40 deg. to 50 deg. Cent. being largely used for levels. Measurements were also given connecting temperature and length of bubble with tubes of the ordinary cylindrical type, together with the relation between the damping of the movement of the bubble and its length, and the relation between damping and diameter of tube. The calibration of levels with particular relation to the presence of faults in the tube was discussed. The determination of the longitudinal radius of curvature of the tube was made, and the effect of departures from the circular form upon the calibration curve of the level commented on. A new method of obtaining calibration curves, by photographing the image of the bubble in a plane mirror, so that the position of the bubble upon the scale is obtained for successive tilts given to the tube was then described. The relations between temperature and width and depth of bubble were set out and the results applied to an explanation of the "constant" bubble of E. R. Watts and Son, Limited, which has the same length at all temperatures.

The second paper was by E. Wilfred Taylor and was entitled "The Primary and Secondary Image Curves Formed by a Thin Achromatic Object Glass with the Object Plane at Infinity." It was pointed out that the shapes of the primary and secondary image curves of an object plane at infinity formed by a thin simple lens are well known and can be readily determined. The object of the paper was to show that the image curves in the case of a double object glass of ordinary thickness, and with the inner curves approximately in contact, correspond very closely to those of a simple lens of the same power, and are only very slightly affected by the use of different glasses.

In a third paper "A New Form of Balloon Theodolite" was described by T. F. Connolly. The theodolite was designed primarily for the observation of drifting balloons when it is desired to follow as closely and consecutively as possible the movements of the balloon and to note periodically the time and the simultaneous altitude and azimuth observed. In the instrument the horizontal and vertical circles are brought together in such a way that a single index serves for reading both. A large field achromatic magnifier is so arranged that a "stand off" view is secured. The magnification is such that the necessary readings and estimations are easily made. The usual vernier has been abolished and replaced by a single index. Estimations of the degree intervals are made on each circle to one-tenth of a degree.

DIE CASTING RESEARCH.

THE British Non-Ferrous Metals Research Association has undertaken an extensive series of investigations on die casting alloys, which will spread over at least three years and entail an expenditure exceeding £10,000.

The development and support of die casting in this country as a means of rapid production is recognised as of great national importance both for ordinary commercial production, in the most diverse industries, as also for munitions and equipment of the fighting services. The Department of Scientific and Industrial Research, after holding a conference of those interested in the subject, has promised substantial financial assistance to the research. The Research Associations of the British motor and allied industries, of the scientific instruments, and of the electrical and allied industries have also afforded their support, and are represented on the committee controlling the investigations.

Various types of alloys are used in die casting, and, because of the wide field covered, the proposed research has been divided into three sections: (1) brass and bronze alloys, (2) aluminium alloys, (3) low melting point alloys (zinc, tin, lead, &c.). These three branches, with suitable arrangements for co-operation, will be dealt with in separate institutions, under the supervision of recognised leaders of metallurgical research. Every care is being taken in the constitution of the committee which controls the work, to ensure that both the manufacturers and the users are represented.

Work of this nature demands the close interest of the industry, and it is hoped that no difficulty will be experienced in obtaining the small subscriptions required to assure the substantial Government support, which is only available in a measure dependent on the backing of the scheme by the industry. An appeal is therefore now being made to the industry—makers and users—to provide their quota of the fund required, as without this it will be impossible fully to develop the work, the results of which will be primarily available to those who support the research. Full particulars of the scheme can be obtained from the headquarters of the British Non-Ferrous Metals Association, 71, Temple-row, Birmingham.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

Spiritless Market.

THE Midland iron and steel market is spiritless. Demand has shrunk to very small proportions, and though both iron and steel makers have granted price concessions in an endeavour to keep their plants going, they have been unavailing. The conditions which prevail do not inspire confidence, and there is little prospect that the June figures of production will show anything like the encouraging increase of the previous month. The falling off in the volume of orders and inquiries has increased all round, and consumers are buying only for immediate needs. The position on the Continent makes it extremely difficult for buyers to know what is going to happen, and they will not risk contracting forward. The low offers of continental material, both iron and steel, are also having an adverse effect upon trade in this district, and though the volume of business which is going abroad is not great, yet the low prices quoted are sufficient to depress the market. At best the outlook is obscure, and the immediate position is anything but heartening. Hopes are entertained that when stocktaking is over at the works, consumers may turn their attention again to buying.

Derbyshire Pig Further Reduced.

The pig iron situation in this district is one which gives rise to much anxiety. Stocks are reported to have accumulated owing to the check which high prices have put upon consumption at home and the declining energy in the foreign demand. Some furnace owners have sold most of their output over the next month or two, but those who are less fortunately placed are forced to reconsider their policy. It requires a good deal of boldness to accept the hazard of putting any considerable proportion of the make into stock at the present cost of production, and with falling values. The market is so unresponsive, however, that it is extremely difficult to find adequate outlets. Indeed, some makers have found it necessary to put some of the product of the furnaces into stock, and, in view of the additional expense thus incurred, are talking of closing down their furnaces. They have found it impossible to get any concession in coke prices, and, in some instances, coke makers are reported to have quoted higher prices for contracts running into the third quarter. Apparently, no substantial reduction can be expected to take place until the heavy exports to the Continent at high prices receive a definite check. After a slow deterioration since the readjustment of a fortnight ago, pig iron is again this week definitely lower in some directions. Derbyshire houses have dropped their quotations a further 2s. 6d. per ton. The movement is not unanimous, but it is decisive as far as it goes. No appreciable business has, however, accrued. Derbyshire forge is now quoted £4 15s. and No. 3 foundry £5 2s. 6d. at furnaces. Buyers are not disposed to pay even these reduced prices, and there is next to nothing being done in forge material. The position has improved slightly as regards foundry sorts, some export orders having relieved the situation. Little change is to be noted in the price of Northamptonshire makes, and there is no Staffordshire pig on the market.

The Iron Trade.

The prospects of the Staffordshire finished iron trade are no brighter than when I wrote last week, and as we are approaching the dead season of the year, there is little likelihood of a real revival before the autumn. The local ironworks are rapidly exhausting their orders, and a number are unemployed this week. Business is increasingly difficult, with dear fuel and the wages increase lately conceded under the sliding scale. A few of the fortunate works have fair orders still to execute in connection with the wagon-building business in progress at local works. Quotations for marked bars remain firm at £14 10s., but for Crown bars the quotation varies from £12 to £12 5s. in South Staffordshire, though the nominal figure remains £12 10s. The North Staffordshire price is £12 10s. Nut and bolt bars are in very slow request, and some Black Country mills have this week reduced their price by no less than 5s. per ton in an endeavour to secure the meagre business coming on to the market. While some mills ask £11 5s., many others are prepared to accept £11. Belgian bars are dearer this week by 7s. 6d. per ton at £8 17s. 6d. delivered here. However, when this is put against the £11 or £11 5s. asked by local producers, it will be understood why so much of the little work available is going to the Continent. Tube makers are but moderate customers for iron strip at £12 10s. They can buy steel so very much cheaper, some 30s. less, that an increasing quantity of the latter is naturally being used for tube making.

Reduction in Galvanised Sheets.

The pressure by consumers for further price concessions which I noted last week, combined with keen competition for a diminishing volume of overseas trade, has had the effect of bringing down the price of galvanised corrugated sheets for export 7s. 6d. per ton to £18 10s. Some local houses still quote £19 2s. 6d. for small orders given out in the district, but others are content to ask £19. Buyers for the home trade are still dissatisfied.

Steel.

In the steel trade locally, orders are being worked off, and one of the Black Country steel works has closed down eleven of the shops. Billets can now be bought at about £8 5s., although £8 10s. is the more general quotation. Belgian prices are slightly firmer at £7 15s., but a good deal of business has already been arranged on the basis of £7 10s. delivered. In the finished steel mills there is very little new business, but the manufacturers are not disposed to extend the recent 5s. reduction. Small bars have been taken by re-rollers this week at £10 10s. This branch of the trade is capturing a good deal of the business, through its ability to take advantage of cheap Belgian billets, which are from 15s. to £1 per ton below native prices. Steel strip is being disposed of at as low as £11, in some cases a fall of nearly 10s. on the week. There are mills, however, who adhere to the £11 10s. basis.

Scrap Falls Half-a-crown.

Prices of steel scrap have undergone a further reduction of 2s. 6d. per ton, some sales having been effected this week at £3 17s. 6d. But these are strictly for urgent requirements, and the large users of steel scrap have not yet found it necessary to come on to the market. They appear to have large supplies of material on hand.

Falling Off of Steel Orders.

Owing to lack of orders and the depression in the iron and steel industry, Alfred Hickman, Limited, Springvale Steel Works, Bilston, have closed down some of their steel casting shops and a number of cupolas. The effect of this is to throw out of employment for an indefinite period about 400 men. The outlook in the steel trade locally is far from bright. Orders and inquiries have been falling away continually for some weeks, and the position of makers has been made worse by the fact that production costs have increased, especially as far as coke is concerned, while selling values are depreciating. Fortunately, the furnaces are still kept going.

Increased Use of Electricity at Coventry.

The annual report of the Coventry Electricity Committee just published reflects the improvement in the city's industrial conditions, as compared with the two previous years. The fact that the majority of the Coventry motor and cycle factories are now electrically equipped for power purposes renders that aspect of the report the more significant. The report shows that the units sold were 34,826,476, as compared with 26,134,570 in 1921–22, an increase of 33 per cent., and the Committee points out that there were periods during the year when the peak load exceeded the figures attained during the war.

Cannock Chase Miners' Wages.

It is generally expected that an announcement of a substantial increase in the wages of Cannock Chase miners for the next two months will be made after the Wages Board, which fixes their rate of pay, meet on Monday next. The rates of pay for the next two months will be based on the coal output and working costs of March and April, and as these were good periods, substantial benefits should accrue to the miners. In May and June the local colliers had an increase of 10d. per day, and they are hoping that another 10d. will be forthcoming in July and August, bringing the minimum wage of the stallmen up to 11s. per day.

LANCASHIRE.

(*From our own Correspondents.*)

MANCHESTER, Thursday.

General Outlook.

SIGNS of the approach of lower prices in the iron and steel markets are multiplying, and it is now a question, not of keeping up the selling values, but of deciding how far they will have to recede before consumers are satisfied that the bottom has been reached. Almost all new buying in this district has ceased, and the general opinion amongst merchants is that trade has never been worse. This is probably an exaggerated view to take, but it cannot be called unnatural. Merchants generally are hoping for much lower prices, which would enable them to get to work again, but these would involve further heavy losses for producers, and already it is reported that reserve funds are becoming exhausted. Meanwhile it seems that the continental producers can work at much lower rates, and in spite of the disturbance in the Ruhr district they are able to offer cheap iron and steel for delivery here.

Metals

The copper market is still in a very puzzling condition, and it is very difficult to form any opinion about it, except perhaps that the fall has been overdone and that some reaction is due. The buying of standard copper by American interests is, of course, with a view to prevent a collapse. It is possible that some of this standard metal may be shipped to America for refining purposes; but the proceeding could not be very profitable, and it is more probable that the bulk of the American purchases will have, sooner or later, to be sold again on this side. There have been larger sales of copper to the Continent lately, but whether this means that the consumption of copper there is on the increase is doubtful. In countries where the paper currency is in such a doubtful state it may well be that people are glad to exchange it, whenever possible, for something of tangible value. Looking at the market fairly, however, it must be admitted that prices of copper—except manufactured prices—are moderate, and that the chances of improvement are much better than they are in many other markets. The quotations for sheet copper and copper and brass tubes have not yet been changed. It is unfortunate that the capacity of the works is so much greater than the present need of the consumer, for this means that real economic production is impossible. The markets here for scrap metals have been very quiet, and dealers seem to be depressed and disposed to offer very low prices. Many will now pay only £46 per ton for gun-metal scrap and £37 for heavy yellow brass scrap. Of course, they are not sellers at these prices, but it is possible for the consumer of metals to buy good scrap now on very favourable terms. There seems to be very little life in the tin market of late. The lower level of prices has induced some buying amongst consumers at home, but apparently the consumption of the metal is barely equal to the present output. America, however, may buy more largely,

as the price must now offer some temptation. On the whole, one is inclined to think that the market has gone back quite far enough. Lead has been a dull market with rather easier prices for a time, but buyers are not satisfied that there is justification for the level of values. Spelter has declined again to a small extent and is now not far off the price of English lead, whereas in normal conditions there ought to be at least £10 per ton difference between them.

Pig Iron.

The markets here for pig iron are, if anything, duller than they were. There seems to be little business about beyond the supply of a truckload here and there and, of course, the regular deliveries against the contracts made long ago at lower prices. Consumers of foundry iron in this district are more than ever confident that by waiting they can get the prices down to a much lower level, and this seems quite possible unless makers in the Midlands determine to blow out furnaces rather than to sell below costs. The price at which the large consumers have been aiming at is about 90s. per ton delivered in Manchester, and to make iron at this price would mean very much cheaper furnace coke. Whether this is a probability remains to be seen, but meanwhile business languishes and the merchants find nothing to do. Cleveland iron is again reported weaker, and it might now be bought at 1s. or 2s. below the nominal price of 115s. on trucks; but, of course, this is of no use to Lancashire ironfounders. The whole market is evidently sagging, but it sags far too slowly, and by the time it has fallen 2s. or 3s. buyers are looking for a fall of 10s. Scotch iron is quoted here at the old price, say, about £6 6s. 3d. per ton delivered; but hematite iron is about 1s. per ton easier than it was last week, and could probably be bought here at £6 5s. per ton.

Steel.

The demand here for manufactured steel is no better, but, if anything, rather worse. There are merchants who would shade £10 per ton for joists and angles, but one does not hear that there are any buyers about. Steel plates are very much neglected at about £10 5s. per ton, but there is said to be a fair amount of work in thin sheet steel. The continental makers have selling agents here for sections, and they quote about £8 5s. to £8 10s. per ton, but do not sell very much.

Scrap.

Dealers in scrap report that they are doing practically nothing. The ironfounders seem for the most part to be out of the market for cast scrap, and although good lots are offered at from 80s. to 85s. per ton delivered it is not easy to find a buyer. The malleable ironworks are not getting many orders for bar iron, and thus are indifferent about buying heavy wrought iron scrap. It is said that one or two works will still take it in at 90s. per ton, but there are others who pay only 85s. per ton, and that when the nominal price of bar iron is £12. Dealers, of course, are highly dissatisfied, and it is really scarcely worth while to collect and prepare the scrap. Heavy steel melting scrap is very quiet, and the value on trucks here is now barely 70s. per ton.

Manchester Association of Engineers.

A large party of members of the Manchester Association of Engineers paid a visit on Thursday, the 21st inst., to the works of the Stanton Ironworks Company, Limited, at Stanton, near Nottingham. The time available for the inspection was altogether inadequate to include an examination of the whole of the company's extensive works, which cover an area of something like 45 acres. It was therefore decided to concentrate the visitors' attention upon the extremely interesting and novel plant and processes for the manufacture of cast iron and concrete pipes which are in operation at the works. The visitors were first shown the plant for "spinning," annealing and testing cast iron pipes, which are made up to 15in. diameter and in 12ft. lengths. It was noted that the finished pipes are much truer than the ordinary sand-cast iron pipe, and owing to the increased density of the metal the spun pipe is not only stronger but thinner than the cast pipe, so that a ton of the former will be of greater length than a similar weight of the latter. The party was next shown the plant and processes of manufacturing the concrete and concrete-lined pipes. Two kinds of concrete pipes are made: the plain and reinforced concrete up to 6ft. diameter and the concrete-lined cast iron up to 54in. The concrete pipes are made in sheet steel casings which open longitudinally to enable the pipes to be removed. Several of these casings are caused to rotate simultaneously at a high speed on special machines by contact with friction rollers, and, while revolving, are charged with concrete by hand at both ends, a process which occupies only a few minutes. After removal from the casings the pipes are lowered into steam-heated chambers, where they are allowed to remain for a period of six to twenty hours for "conditioning" before being stacked in the open yard. The process of lining cast iron pipes with concrete was also demonstrated. This process was described in THE ENGINEER for May 18th last. These concrete-lined pipes are, it is thought, likely to displace the ordinary unlined pipes for water supply purposes, as they are found to prevent incrustation. The Manchester pipe lines furnish a conspicuous example of trouble from that source, for their capacity is, in the course of a few years, very materially reduced by incrustation. The visitors were hospitably entertained by the Stanton Ironworks Company, Limited, and a vote of thanks was accorded the company, on the motion of Mr. C. Bentham, president of the Association. Mr. E. J. Fox, the managing director, and Mr. Crompton replied to the vote of thanks.

BARROW-IN-FURNESS, Thursday.

Hematite.

The condition of the hematite pig iron trade is rather interesting in a sense. While makers are gradually clearing off the orders placed some time ago, the amount of fresh business is not enough to replace them. Whether this shortage of orders is due to a falling off in trade generally or is evidence that customers are holding back for further reductions in price, it is difficult to tell. The present price for mixed numbers is firm and likely to be for a week or two, and even then there does not seem much chance of a fall. Orders which are being placed at present are from home and continental buyers, but are for immediate necessities, hand to mouth, as it were. It is known that the requirements of some are considerable, but those who want pig iron are not keen to buy to-day. The boom which was started by the Ruhr business seems to have come to an end and left matters as bad as, if not worse, than they were some time ago. A settlement of the German problem might help to stabilise the market, which is dull and uncertain at present.

Iron Ore.

The amount of iron ore raised in the district is reduced, and as not much is being sent out of the district, if there is a restriction of the number of furnaces, the iron ore trade locally will feel the effect immediately. As far as foreign ore is concerned, the trade is not very brisk, and there were no arrivals last week at Barrow.

Steel.

The steel trade is moderate. There are no rails being rolled in Cumberland, the works there being only engaged upon tires and sleepers. The Barrow works are on rails still, and there were several shipments last week from Barrow of part cargoes for abroad. The hoop mills and the small bar mills are engaged. Shipbuilding and engineering are being interfered with by the prolongation of the boilermakers' dispute. A great number of skilled engineers have left Barrow through inability to obtain employment and have gone to America, and reports received are to the effect that skilled men have no difficulty in securing good jobs over there. A smart young man, barely twenty-three, who served his time at Barrow, has taken up a good job and is about to be made a foreman in one of the American engineering shops. This makes some of the old-fashioned foremen in this district gasp.

SHEFFIELD.

(From our own Correspondent.)

The Decline in Open-hearth Steel.

IT is unfortunately impossible to write anything about the prospects of the open-hearth steel trade which will put a better complexion on the situation than it has worn during recent weeks. Rather is it the case that each week brings increased cause of dissatisfaction. The great demand for commercial steel which set in shortly before the end of last year and caused range after range of big furnaces to come into active operation is not maintained. For weeks now the placing of fresh orders has been on a very small scale, and work has been practically confined to the execution of old contracts. Now those contracts are approaching completion, and the buying slump continues. Unless some sudden change takes place—of which there is no sign—the outlook for the next quarter cannot be regarded as favourable. Makers maintain that lower prices would not help the situation much, and also that they cannot afford to give substantial reductions.

The Lighter Trades.

Coincident with this falling off in the heavy steel trades there are reports of a somewhat better state of things in some of the lighter branches. The depression in crucible steel and tool steel is still serious, but is mitigated by a spot of brightness here and there. A minority of firms in the tool steel trade have done very much better during the last week or two than at any time this year. Edge tools continue to enjoy a very good demand, the call for spades and shovels, hand saws, axes, farm and excavating tools, heavy hammers and the like keeping up very well. The unsatisfactory nature of the general situation is shown, however, by the heavy unemployment figures, in which there was a slight increase according to the latest return.

Cutlery and Plate.

One cannot do much more than repeat the unfavourable things which have been said about the condition of these branches week after week for a considerable time. While there is a large output of table cutlery, spoons and forks, the trade is not sufficient to go round. The most noticeable new feature is an improvement in buying from the British Dominions, which are the city's principal export markets. The home demand is very slow, and shopkeepers continue to give reports which are the reverse of cheerful.

Important Fusion Proposal.

A matter of much commercial and engineering interest which has come to the front since I last wrote is a proposal for the amalgamation of Cammell Laird and Co., Limited, of Sheffield and Birkenhead, the well-known shipbuilders, manufacturers of armaments, railway material, and other steel products, with the Leeds Forge Company, Limited. Cammells have offered to acquire the shares in the Leeds Forge Company on the basis of one of their ordinary shares for every two Leeds ordinaries, and one ordinary for each preference share. The directors of the Leeds Forge Company are recommending their shareholders to accept the offer. The Leeds Forge Company is one of the largest engineering concerns in the North. It manufactures steel, railway rolling stock, boiler plates, &c., and is at present busily engaged on railway supplies, principally for the continental services. If the negotiations are carried through the combine will be one of the most important in the engineering trades of the country.

Overhead Electric Cables.

The Electricity Department of Sheffield Corporation is at present extending its facilities into some of the more distant suburbs of the city, and is adopting the method of conveying current by overhead cables instead of by underground mains. At present a cable is being installed in the Woodbank-crescent district, nearly three miles from the centre of the city, and the same process is to be carried out at Handsworth, Woodhouse, Abbey Lane, and Norton, which are still further afield. The Department explains that it is adopting the overhead system for these outlying districts because that is the only way in which the installation of electricity can be made a commercial proposition. It is a difficult and costly proposition to lay cables underground to places miles out of town, and wiring overhead is much cheaper. The accounts show that the expenditure on mains for the year ended March, 1922, was £120,000. The new system will be one-third to one-half cheaper, so that a considerable saving will be effected annually. It is pointed out that there is very little danger in the overhead system. The protective regulations drawn up by the Electricity Commissioners are so stringent that any untoward occurrence is very unlikely.

New Type of Tramcar.

An interesting exhibit at the conference of the Municipal Tramways Association in Hull this week is a new type of light tramcar invented by Mr. E. S. Rayner, manager of the Hull Corporation tramways undertaking. The system of transmission is a new feature, as it is similar to that used in motor cars, but the car will run on lines. By the aid of a double worm drive light motors can be used instead of the heavy motors with heavy gears at present in use. It is claimed that the car will result in a considerable economy in maintenance cost and electric current consumption. The weight of the car has been reduced from 12 tons to 8 tons, and the holding capacity is sixty-four, which is rather higher than that of the present type of car. A feature is a seat for the driver, and there are interior steps leading to the top deck, while room for standing passengers is provided at either end.

Tully Gas at Horncastle.

The Urban Council of Horncastle is anxious to get on with its new lighting scheme, as there is a fear that unless something is done at once the town will be in darkness during next winter. The present plant is derelict, and it is proposed to install a new Tully gas plant, but up to the present the scheme has not been approved by the Ministry of Health, nor has permission for the raising of a loan been obtained. There is every hope, however, that progress will be made very soon. The chairman of the Gas Committee and the Town Clerk have interviewed the Board of Trade and have found the authorities there anxious to assist the Council to push the matter along. It has been decided to ask the Ministry of Health to hold an inquiry into the proposal.

Works Extensions.

The directors of Davy Brothers, Limited, engineers, Sheffield, in their annual report, state that they have begun the erection of an additional ironfoundry at the Darnall works, which will be fitted with the most up-to-date appliances. The Stanton Ironworks Company reports that the works laid down at Stanton for the manufacture of "spun" iron pipes, under the manufacturing rights acquired from the International De Lavaud Manufacturing Corporation, Limited, have been completed, and orders for these pipes are being received in increasing quantities. The Stanton-Hume concrete pipe, manufactured under licence from the Hume Pipe and Construction Company, Limited, is being extensively used for water and sewerage purposes. The Riddings works, which were completely shut down a year ago, have again been put into operation. Including the furnaces at Holwell and Riddings, the company is to-day operating thirteen out of its seventeen furnaces.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

THE general position in the Cleveland pig iron trade is practically unchanged from last week and very discouraging. In all branches producers are rapidly getting through their contracts on hand, and are becoming perturbed at the continued dearth of new business. Bear influences are still too strong for the makers, and with prices continuing on the down grade, there is every inducement for buyers to withhold purchases to the last possible moment. It is generally agreed that customers are not likely to return to the market until a further substantial drop in quotations occurs, but makers point out that current rates leave no margin of profit, and there seems little likelihood of relief by way of reduced cost of output. The fact cannot be overlooked, however, that Cleveland foundry iron is now the dearest in the country. Thus Cleveland is losing ground in the home market, and the foreign demand has tapered off to an alarming extent. Indeed, a little Belgian iron is being brought into the district. Makers are now willing to accept 114s. per ton for No. 3 Cleveland pig iron—possibly even less—but buyers still regard the price as far too high, and only very small lots are being sold. No. 4 foundry is about 111s. 6d., and No. 4 forge 107s. 6d., whilst No. 1, which is not so scarce, might be bought at 125s. per ton.

Hematite Pig Iron.

The demand for East Coast hematite pig iron is equally quiet, and the disturbed state of the foreign exchanges is a drag on export business. Prices are largely a matter of arrangement, and are fixed according to the size of the order. A fair average price, however, for mixed numbers is 112s. 6d., with No. 1 at 113s. 6d. per ton.

Iron-making Materials.

There is no indication of any resumption of business in foreign ore, consumers being reluctant even to

take full deliveries under running contracts. But prices have been cut to the bone, and sellers are not inclined to cut the price of best Rubio, which remains at 24s. per ton c.i.f. Tees. An easier tendency is reported in the coke trade. There has been a drop of 1s. per ton, but prices will have to fall much further to afford any appreciable relief to the ironmaster. Good medium furnace qualities are quoted at 41s. 6d. per ton delivered at the works.

Manufactured Iron and Steel.

Quiet conditions also prevail in the manufactured iron and steel trade. The market is not entirely inactive, but most of the orders being placed are for small quantities, buyers evidently having decided upon hand-to-mouth purchases until there is some indication of lower values. But in spite of the fall in pig iron and scrap the steel makers adhere fairly closely to recent quotations, and only here and there are prepared to make concessions. The boilermakers' strike is hitting hard the steel works on the North-East Coast, some of which rely very largely on shipbuilding specifications.

The Coal Trade.

The Northern coal trade is generally improved in tone all round, though any alteration in prices is very small. The only disturbing factor of any note comes from Norway, where all the paper and pulp mills' workers are said to be on strike. This will, of course, affect the volume of shipments from the North-East Coast to that country, though the influence cannot be very great. Otherwise, with the exception of Italy and other Mediterranean countries, where the American competition is very strong, there is a fair and comprehensive inquiry from Europe, and some rather extensive buying is expected to develop in the near future. For next month and onwards the general opinion seems to be that there will probably be a slow but gradual improvement all round. There are, however, not wanting those who anticipate that some arrangement between France and Germany must soon be effected, and that when that takes place there will be a cessation, or, at any rate, a considerable reduction, of shipments to Germany, which will react adversely on coal prices there. So far, however, the omens for the future are all in the direction of the present rising tendency continuing for some time ahead. The outstanding feature of the market this week has been the placing of a number of large contracts for coking coal for forward deliveries at very good prices. Among these is a deal in prime unscreened coking—Brancepeths—at 32s. 6d. f.o.b. in monthly lots from July to December next, the quantity being 115,000 tons to 120,000 tons—19,000 tons to 20,000 tons per month. Another contract for first grade coking coals has also been completed at 32s. 6d. per ton f.o.b. with delivery from July to March next year. The quantity is 10,000 tons per month, totalling about 90,000 tons. The tone in Northumberland steam coals of every kind is improving, and values are slightly enhanced for July, with a prospect of some heavy commitments developing for the later months of the year. Best screened and best and prime smalls are distinctly firmer. Secondary sorts are following up very closely, with no disposition on the part of collieries to discount prices for July and onwards. The Durham gas coke section is showing increased activity, and for July and onwards the prices for every brand and all qualities are distinctly on the mend. The bunker market is irregular for spot, and cheap lots are often obtainable, but the outlook is improving. The coke market is steady for all classes of foundry and furnace and all makes of gas coke.

Coal Miners' Wages.

Northumberland coal miners' wages will be considerably increased during July and August. The joint report of the accountants shows that the wages payable will be at the rate of 138.55 per cent. above the basis, as compared with 105.15 per cent. in May and June. This will mean an advance in the wages of hewers of about 1s. 8½d. per shift, and other classes of labour at the mines will also benefit. The improvement in the export coal trade and the high prices realised for all classes of coal are responsible for the big increase in wages.

SCOTLAND.

(From our own Correspondent.)

Conditions Unchanged.

STILL another week has passed without bringing any improvement in trade generally. Markets are very unsettled and buyers adhere to their policy of inaction until a steadier tone is apparent. The trouble at the shipyards has had a considerable lot to do with bringing about the present state of affairs, and the consequences may be more far-reaching than anticipated. Apart from the interference with operations at the yards orders have been lost to allied trades which may never now be placed in this country. Unemployment is growing, and with the outlook seemingly fairly hopeless in this respect at present large numbers of workers are leaving the district or have already left for the United States and Canada. As a matter of fact, had it not been for the limitation of immigrants to the countries mentioned it is fairly certain that west-going liners would have been filled up with all classes of tradesmen for some months ahead.

Another Ship for Dundee.

Shipbuilding orders are still being placed, despite the situation in the industry, and amongst the latest contracts mentioned is one for a motor ship of 8000 tons, to be built by the Caledon Shipbuilding and Engineering Company, Dundee, for James Chambers and Co., Liverpool.

Pig Iron Still Easing.

The prices of Scotch pig iron recorded a further fall last week to £5 17s. 6d. per ton for hematite, £5 15s. No. 1 foundry, and £5 10s. No. 3 foundry. The past week has again been a dull one, the demand both on home and export account being restricted to immediate requirements, which are exceedingly small meantime. The production is slowing down, but supplies are fairly plentiful, and a further reduction in quotations is likely.

Mills on Short Time.

The lack of fresh business in steel and iron is becoming more acute, and the works in the Lanarkshire area especially are already feeling the pinch. Some have been able to maintain a fair degree of activity owing to the amount of orders booked during the last "boom" period, but producers of plates and sections have had a very lean time for some weeks back and have almost nothing to replace orders when completed. Home prices of plates and sections are yet unchanged, but export transactions can be carried through at a considerably cheaper rate. Steel sheet makers have still a fair amount of old orders on hand, but even they are booking little in the way of fresh business, apart from occasional lots of the lighter gauges for export. In the bar iron trade conditions are giving cause for anxiety. Short time is becoming more general, and the lower prices obtained for any sales effected will mean a further reduction in the wages of the workers. The re-rolled steel departments have not yet reached the same stage of unemployment, but are in the same position as others with regard to new business. It is said that overseas orders are in prospect, but that buyers will not commit themselves until steadier conditions are in prospect or accomplished.

Coal Prices Still Falling.

The coal market has shown no fresh symptoms during the week. In the export department negotiations have been difficult owing to continued fluctuations in prices. Most of the collieries are on the outlook for orders and have lowered their terms, while at the same time further supplies have been forced on the market by holders anxious to unload their obligations. Considerable undercutting has been indulged in, but with very varying success. All descriptions of round coal have been slow to move, and though washed nuts seemed a little more active, the actual turnover was exceedingly small. With good shipping facilities old contracts are being quickly worked off and exports have been heavy, the aggregate returns for the week amounting to 336,110 tons, against 306,094 tons in the preceding week and 278,002 tons in the same week last year. The bulk of the shipments went to Germany and Scandinavia, with small lots to North France and Belgium. Home requirements are very easily satisfied at present. Industrial demands are at a low ebb and municipal deliveries are small even for the season of the year. The scarcity of orders from these two principal outlets is a serious consideration for the collieries concerned. Shipping prices continue to weaken, and while this movement is in progress buyers abroad are evidently content to hold off in the expectation that a comparatively cheap level of prices will yet be established.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

THE steam coal trade position continues to be somewhat unsettled, and there has been a further fall in values since I wrote a week ago. The general inquiry is still far short of the normal, and the tone is easy, though there are indications that the market is finding its level. The reduction in prices, which has been so rapid during the past fortnight, is bearing fruit, inasmuch as the demand coming along is better; but naturally there is a disposition on the part of foreign buyers to postpone operations as long as possible for fear that prices may even yet go lower, while it is also the case that the foreign exchanges are having an adverse effect upon business. It is probable that the market is in for a quiet time for a month or so, but it would be no surprise if the conditions then become much steadier as the belief is held that Germany will before very long be again in the market for supplies. There are also tentative inquiries for considerable quantities of coal from other directions for delivery over six and twelve months, which fact shows that business ahead is possible provided that the price is right. The Egyptian State Railways which recently asked for tenders for 120,000 tons to 160,000 tons of locomotive coals for delivery over the remainder of this year are reported to have placed the order with two firms, viz., Watts, Watts and Co., and Furness, Withy and Co., both of whom have shared in this business on a previous occasion. It is understood that the order has been taken at round about 40s. per ton c.i.f. Alexandria, which, on the basis of 11s. freight, leaves 29s. for the cost of coals, profit, &c.

Miners' Wages.

It is probable that in the course of a few days the result of the audit for the ascertainment of the proceeds and the fixing of the wage rate in this coalfield for the months of July and August will be made known. The rate for July and August is governed by the figures for April and May, and in view of exports for the latter months being larger and prices higher than they had previously been, it is generally concluded that the audit will show a substantial rise in the miners' wage rate. In some quarters it is suggested that the increase may be anything from 15 to 20 per cent. on the standard, but more conservative and reliable estimates give the prospective increase as 12 per cent. This will mean that the wages of the average miner will benefit by several shillings weekly, and that the pay of the best men will be increased by anything up to 10s. a week. Unfortunately, if the increase in wages as a result of the audit is only 12 per cent. the lowest paid workmen in the coalfield will not reap any advantage, as under the Buxton award a subsistence wage allowance of 15 per cent. on the standard over and above the minimum rate in force is paid them, and this subsistence allowance is to come off if there is an increase of wages equivalent to it or if the cost of living falls in a corresponding measure.

Miners' Resolutions.

On the concluding day of the South Wales Miners' Federation's annual conference last week numerous resolutions were adopted, many of them somewhat on the lines of resolutions passed in previous years. It was decided that action should be taken to bring about one union only for the coalfield, and that efforts should be made to abolish all large coal price lists and substitute through coal price lists. The Miners' Federation of Great Britain is to be asked to take action in regard to safety men during a national strike by preventing other than safety men of the Miners' Federation from working during the strike or lock-out period. The nationalisation of mines is also to be pressed forward, and every lodge is instructed to take show-cards every two months. There is to be an attempt to abolish all piecework.

Dock Charges.

The general committee of traders at South Wales ports had an interview last week with the general manager of the Great Western Railway Company for the purpose of making application for a reduction in dock charges, and an agreement was arrived at whereby dock charges, including tonnage dues, wharfage and cranage, shall be reduced from 75 to 60 per cent. above pre-war charges, and tipping and weighing charges from 8d. to 7½d. per ton. These reductions are to operate as and from July 1st.

Current Business.

The volume of business passing on the steam coal market has again been very restricted though slightly better than was the case last week. Prices of both large and small coals have fallen, and this has produced slightly more activity, but operations are a very long way from being brisk. Best Admiralty large coals are not worth more than 30s., though in one or two cases more might be asked by the collieries. Second Admiralty large coals are round about 29s., while in the case of superior small coals supplies can be secured for July shipment at 22s. 6d. to to 23s. 6d. The better classes of Monmouthshire large coals can be bought at 27s. 6d. to 28s. 6d. Coke shows a rather wide margin, and is quoted at 50s. to 60s. Anthracite coals keep very steady, especially the sized qualities. Cobbles, nuts, beans and peas are very fully booked up for the next month. Patent fuel is rather on the quiet side and prices are easier.

Latest News from the Provinces.

NORTH OF ENGLAND.

Further Drop in Pig Iron Prices.

CONSUMERS of Cleveland pig iron continue to act with extreme caution, confining their operations to purchases sufficient for early essential needs. No. 3 G.M.B. Cleveland pig iron is now obtainable at 112s. 6d. per ton, and it is stated that a substantial order can be placed at less than that figure. No. 1 is as scarce as ever, and quoted 125s. No. 4 foundry is rather a drug on the market at 110s., but the quantity of No. 4 forge available is not large, and the price is firm at 107s. 6d.

Australian Engineering Notes.

THE Melbourne Harbour Trust has purchased Williamstown Dockyards from the Commonwealth for £150,000. The Trust proposes to construct a dry dock capable of accommodating the largest oversea liners.

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EXTENSIVE additions to its transmission service are planned by the Adelaide Electric Supply Company. The lines will be extended from the outskirts of the city to Gawler and Mt. Lofty. Three-phase, 50-cycle current will be transmitted to Gawler at a pressure of 33,000 volts, with transformers at Salisbury and Gawler. It is hoped to have the work completed by September or October next.

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THE standardisation of electrical power in the Commonwealth is apparently projected by the Federal Government. The Prime Minister broached the subject in his recent policy speech, delivered at Perth, W.A. He said that the Government believed, in view of the experience of other countries, that co-operation between the Commonwealth and the States, whereby electrical power schemes would be standardised, should be brought about, and declared that the Cabinet considered it essential that immediate steps should be taken to co-ordinate the whole of the electrical power schemes of Australia, and that definite proposals would be submitted for this purpose.

EMPIRE TRADE.—We learn that a new organisation, the British Overseas Trade Association, Limited, has been formed to promote and foster trade within the Empire. The Advisory Committee consists of the Right Hon. Lord Ampthill, G.C.S.I., G.C.I.E. (president), the Right Hon. Sir Gilbert Parker, Bart., Sir T. Vansittart Bowater, Bart., Sir J. Lulham Pound, Bart., while the directors are Sir Lawrence Wallace, K.B.E., C.M.G. (chairman), Colonel Sir Alexander Sprot, Bart., C.M.G., D.L., Lieut.-Colonel W. A. J. O'Meara, C.M.G., and C. E. Town.

JUBILEE EXHIBITION IN GOTHENBURG.—In connection with the Jubilee Exhibition in Gothenburg a series of meetings is to be held in Gothenburg as follows:—August 13th, meeting of General Shipping Society of Sweden; August 14th, meeting of Swedish Societies of Naval Architects; August 15th, meeting of Committee Maritime International; August 16th, meeting of Society of Northern Shipowners; August 17th, meeting of Society of Swedish Shipowners; August 18th, meeting of Society of Swedish Shipmasters. Any members of the Institution of Naval Architects who desire to attend the above meetings will, we are asked by the secretary of that body to state, be welcome, and should communicate as soon as possible with the secretary, Captain Olof Traung, the Maritime Museum, Gothenburg, Sweden, who will arrange for rooms and cards of admission to the exhibition and meetings.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	26/-
(1) Spanish	24/-
(1) N. African	24/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	24/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 17 6	—
No. 1 Foundry	5 15 0	—
No. 3 Foundry	5 10 0	—
N.E. COAST—		
Hematite Mixed Nos.	5 12 6	5 12 6
No. 1	5 13 6	5 13 6
Cleveland—		
No. 1	6 5 0	6 5 0
Silicious Iron	6 5 0	6 5 0
No. 3 G.M.B.	5 12 6	5 12 6
No. 4 Foundry	5 10 0	5 10 0
No. 4 Forge	5 7 6	5 7 6
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge *	—	—
,, ,, Foundry	5 7 6 to 5 10 0	
(3) Northampton—		
Foundry No. 3	5 2 6	—
,, Forge	4 11 0 to 4 15 0	—
(3) Derbyshire—		
No. 3 Foundry	5 2 6	
Forge	4 15 0	—
(3) Lincolnshire—		
Basic	5 5 0	—
Foundry	5 2 6 to 5 5 0	—
Forge	5 0 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	6 5 0†	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 0 0	—
Best ,,	—	—
N.E. COAST—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	12 0 0	—
Second Quality Bars	11 5 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	12 10 0	—
Best ,,	13 10 0	—
Hoops	15 10 0	—
MIDLANDS—		
Crown Bars	12 0 0 to 12 10 0	
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	11 0 0 to 11 5 0	
Gas Tube Strip	12 15 0 to 13 0 0	

STEEL.

	(6) Home £ s. d	(7) Export. £ s. d.
(4) SCOTLAND—		
Boiler Plates	13 0 0	—
Ship Plates ½in. and up	10 5 0	-
Sections	10 0 0	—
Steel Sheets ⅛in. to ½in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 17 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	14 0 0	—
Joists	10 0 0	—
Heavy Rails	10 10 0	—
Fish-plates	14 10 0	—
Channels	9 5 0	—
Hard Billets	10 15 0	—
Soft Billets	10 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 10 0†	—
Light ,,	12 0 0†	—
Billets	11 0 0†	—
MANCHESTER—		
Bars (Round)	11 10 0 to 11 15 0	
,, (others)	10 5 0 to 10 15 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	10 5 0 to 10 10 0	
,, (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	13 0 0	—
Bessemer Billets	13 10 0	—
Hard Basic	10 15 0	—
Intermediate Basic	10 10 0	—
Soft Basic	8 15 0	—
Hoops	12 15 0 to 13 5 0	
Soft Wire Rods	13 0 0	—
MIDLANDS—		
Small Rolled Bars	10 10 0 to 10 15 0	
Billets and Sheet-bars	8 5 0 to 8 15 0	
Gas Tube Strip	11 0 0 to 11 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	18 10 0 to 19 2 6	
Angles	10 0 0	—
Joists	10 0 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 15 0 to 11 0 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	23/1½
Block Tin (cash)	188 15 0
,, (three months)	187 15 0
Copper (cash)	65 5 0
,, (three months)	65 15 0
Spanish Lead (cash)	25 0 0
,, (three months)	24 5 0
Spelter (cash)	28 0 0
,, (three months)	28 10 0
MANCHESTER—	
Copper, Best Selected Ingots	70 10 0
,, Electrolytic	73 0 0
,, Strong Sheets	100 0 0
,, Loco Tubes	0 1 2
Brass Loco Tubes	0 1 0½
,, Condenser	0 1 2½
Lead, English	26 10 0
,, Foreign	25 10 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/5½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	10/6
,, 6 p.c. to 8 p.c. ,,	£21 0 0	8/-
,, 8 p.c. to 10 p.c. ,,	£20 0 0	8/-
,, Specially Refined		
,, Max. 2 p.c. carbon	£50 0 0	18/-
,, ,, 1 p.c. ,,	£60 0 0	21/-
,, ,, 0·75 p.c. carbon	£70 0 0	22/6
,, carbon free	1/6 per lb.	
Metallic Chromium	4/6 per lb.	
Ferro Manganese (per ton)	£18 for home, £20 for export.	
,, Silicon, 45 p.c. to 50 p.c.	£13 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£21 0 0 scale 6/- per unit	
,, Vanadium	16/9 per lb.	
,, Molybdenum	9/6 per lb.	
,, Titanium (carbon free)	1/1 per lb.	
Nickel (per ton)	£130	
Cobalt	12/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	21 3
,, ,, Ell	22/-
,, ,, Splint	28/6 to 25/-
,, ,, Trebles	24/
,, ,, Doubles	22/6
,, ,, Singles	21/3
AYRSHIRE—	
(f.o.b. Ports)—Steam	21 3
,, ,, Splint	23/6
,, ,, Trebles	24/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	20/9 to 25/3
Screened Navigation	30/-
Trebles	24/6
Doubles	22.6
Singles	21/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	23/6
Secondary Steam	21/3
Trebles	24/9
Doubles	22/9
Singles	21·6

ENGLAND.

(8) N.W. COAST—	
Steams	31 6
Household	46/6 to 57/6
Coke	48/-
NORTHUMBERLAND—	
Best Steams	26/6 to 28/-
Second Steams	25/- to 26/-
Steam Smalls	16/6 to 18 6
Unscreened	20/6
Household	25/- to 28/-
DURHAM—	
Best Gas	30/- to 32/6
Second	28/- to 31/-
Household	25/- to 28/-
Foundry Coke	60/- to 65/-
SHEFFIELD—	INLAND.
Best Hand-picked Branch	32/6 to 34/6 —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	25/6 to 27/6 —
,, ,, House	23/- to 24/6 —
,, ,, Large Nuts	20/6 to 22/6 —
,, ,, Small ,,	18/- to 20/- —
Yorkshire Hards	21/- to 23/- —
Derbyshire ,,	20/- to 22/- —
Rough Slacks	12/- to 14/- —
Nutty ,,	11/- to 13/- —
Smalls	7/- to 9/- —
Blast Furnace Coke (inland)	31/- to 34/
,, ,, ,, (Export) f.o.b.	40/- to 41/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	29/6 to 30,6
Second ,, ,,	28 6 to 29/6
Best Dry Large	29/6 to 30,6
Ordinary Dry Large	28/6 to 29 6
Best Black Vein Large	29/- to 30 -
Western Valley ,,	28/- to 29/-
Best Eastern Valley Large	27/- to 28/-
Ordinary ,, ,,	26/- to 27/-
Best Steam Smalls	23/- to 24/-
Ordinary ,,	19/- to 21/-
Washed Nuts	30/- to 32/6
No. 3 Rhondda Large	35/- to 37 6
,, ,, Smalls	25/- to 27 6
No. 2 ,, Large	25/- to 26/-
,, ,, Through	23/- to 24/-
,, ,, Smalls	20/- to 21/-
Coke (export)	50/- to 60/-
Patent Fuel	36/- to 38/-
Pitwood (ex ship)	28/- to 29/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	50/- to 55/-
Seconds	45/- to 47,6
Red Vein	34/- to 35/-
Machine-made Cobbles	62/6 to 65/-
Nuts	57,6 to 62/6
Beans	45/- to 47/6
Peas	25/- to 26/-
Breaker Duff	12,6 to 13/-
Rubbly Culm	17/- to 18/-
Steam Coals:	
Large	26/- to 27/6
Seconds	23/6 to 26/-
Smalls	18/- to 22/-
Cargo Through	22/6 to 25/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

Quotations extremely high and nominal. † Latest Quotations available.

French Engineering Notes.

(From our Correspondent in Paris.)

An International Steel Union.

THE situation in which this country is placed by the readjustment of territories, whereby its iron ore resources have been vastly increased without, however, obtaining the coke necessary for smelting the ore, has raised problems which are further complicated by the fluctuations of money values. As matters now stand, the French have no alternative but to send the bulk of their iron ore production abroad, but as this is not economically profitable to them, and only serves to provide foreign manufacturers with the means of supplying cheaper rolled iron and steel in other markets, they find it necessary to resort to extreme measures in order to utilise the ore in their own blast-furnaces. Consequently, the policy adopted by the French has been to do what is necessary to ensure supplies of coke and to carry out arrangements with foreign producers to stabilise iron and steel prices in markets abroad. It may be taken for granted that the coke problem will be solved at some time or another. The stabilisation of prices was attempted about eighteen months ago when a conference of mill and forge owners from Great Britain, France, Belgium and Luxemburg was held in Paris for the purpose. It was stated at the time that the conference broke down through the exactions of the Belgian and Luxemburg producers, but it is now affirmed that the British representatives were averse from entering into a continental union. However this may be, efforts are now being made to revive negotiations in the hope of finding a way out of the serious difficulty which has been created, not only by the falling off in the supplies of coke from the Ruhr, but also by the reported decision of the Belgian Government to suppress exports of coke to France, on the ground that this country is not supplying the quantity of scrap it undertook to send into Belgium in return for stated monthly consignments of coke. It is affirmed here that if the scrap is not being sent into Belgium it is because there is no demand for it, and that the reported decision of the Belgian Government to prohibit the export of coke must be due to a misunderstanding. Therefore it is hoped that a further conference will be held to clear up these difficulties and arrive at a general agreement between Allied countries. If this fails, there is a veiled threat that France may be forced, if it be possible, to come to an arrangement with Germany, and also with Belgium, whereby a continental union of iron and steel producers would be opposed to the interests of British makers. The situation is evidently fraught with possibilities that should not be overlooked by British mill and forge owners.

Marc Seguin.

Following upon the railway centenary celebration at Andrézieux, a committee was formed to erect a statue to Marc Seguin in his native town of Annonay. The statue will be unveiled by the President of the Republic on July 10th. Marc Seguin, who was born on April 20th, 1786, and died at the age of ninety, was trained by his uncle, Joseph de Montgolfier, the famous scientist and engineer, and early began an active industrial career in which he was closely associated with the creation of new industries, and especially with the development of water and rail transport. He built the first suspension bridge in 1823, and his system of cable suspension immediately met with success, not only in France, but also in other countries. His name, however, is more closely associated with the water-tube locomotive boiler. He was responsible for the construction of the first railway between Saint-Etienne and Lyons, and his multitubular boiler allowed of the speeds of locomotives being increased from 6 kiloms. to 40 kiloms. an hour. The literary work of Marc Seguin was considerable, and in 1866 he published a book on aviation and aerial navigation, which foreshadowed much of the progress that has since been made.

Power Alcohol.

The putting into operation of the Bill requiring importers of motor fuels to purchase from the State a quantity of alcohol equal to 10 per cent. of the previous month's importation of mineral spirit has raised so much controversy that it is difficult to see how the measure can become effective. The object of creating a "national fuel" is not only to reduce the country's dependence upon foreign oils, but more especially, for the moment at any rate, to enable the State to dispose of the huge stocks of power alcohol it has accumulated since it took over a monopoly of the purchase and disposal of spirit distilled from beet, grain and other produce. While the Union of Gas and Oil Engine Builders has been strongly supporting the Government's policy by affirming that a mixture of alcohol and petrol gives perfectly satisfactory results, and that consequently the use of alcohol should be encouraged, others assert that the cost of the "national fuel" must be necessarily higher than petrol, unless the State sells power alcohol at a price considerably below the cost of production, which, indeed, it is doing at the present moment. So far as engine builders are concerned, the compulsory use of alcohol will necessitate certain modifications and adjustments that will induce users to employ French engines constructed for the purpose, and to that extent builders will be relieved of much of the competition from foreign firms. On the other hand, the stimulus given to the production of alcohol is having the effect of utilising huge quantities of beet and grain which could be more profitably employed for the manufacture of sugar and other produce. The distillation of alcohol from beet and grain necessitates considerable labour, which is wanted elsewhere, and consumes a great deal of imported fuel, so that the economical advantages of power alcohol would appear to be illusory.

Oil Tanks.

The Minister of Marine is asking credits for the construction of oil tanks having a capacity proportionate to the requirements of the ships to be constructed in three periods under the new naval programme. To provide for the vessels being built during the first eight years, the Minister proposes to construct tanks having a total capacity of 340,000 tons. The work is to be completed in 1929 at an estimated cost of 60 million francs.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

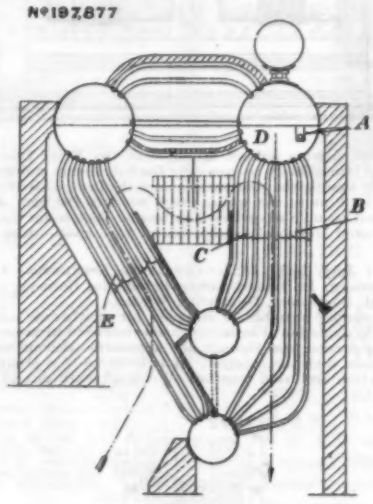
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

197,877. August 8th, 1922.—WATER-TUBE BOILERS, *The Stirling Boiler Company, Limited, 54, Victoria-street, Westminster.*

In this boiler the feed water is deliberately introduced into the outside rows of tubes, which are most strongly heated and thus possess the highest velocity. The feed pipe is shown at A. The

N°197,877



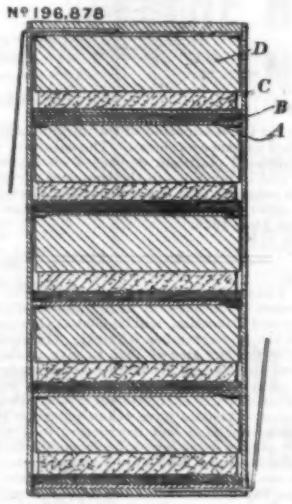
water first goes to the downcomer tubes B, as it is screened from the tubes C by the partition D, goes up the strongly heated tubes E and then joins in the general circulation of the boiler.—*May 24th*, 1923.

BATTERIES AND ACCUMULATORS.

196,878. May 31st, 1922.—IMPROVEMENTS IN DRY BATTERIES, Société Anonyme Le Carbone, of Nos. 12 and 33, Rue de Lorraine Levallois-Perret, Paris.

The improved battery described in this specification is composed of a series of cells piled on top of one another. A zinc disc A constitutes the negative electrode. On this disc are placed discs B of blotting paper impregnated with a solution of ammonium chloride, to which has been added a hygroscopic solution, such as a solution of zinc chloride ($ZnCl_2$) or calcium chloride

N°196,878

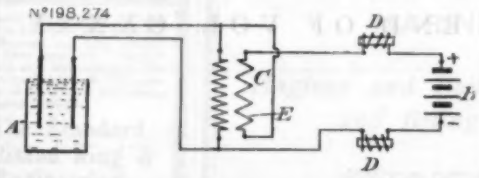


($CaCl_2$). These discs B of blotting paper are surmounted by a disc C cut out of electrolytic paste deprived of a portion of its water. This electrolytic paste may consist, for instance, of a jelly composition similar to that which is usually employed as a binding agent in dry batteries, and is impregnated with electrolyte. Above the binding discs C there are discs D of porous charcoal. The various cells constructed in this way are piled upon one another as shown.—*May 24th*, 1923.

198,274. August 22nd, 1922.—DEPOLARISING ELECTROLYTIC APPARATUS, W. D. Nickum, 103, Chestnut-street, Glendale, Los Angeles, California.

This invention is concerned with a method of depolarising

N°198,274



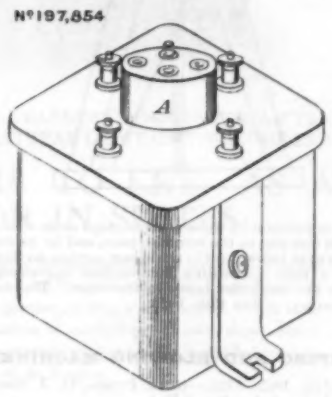
electrolytic apparatus which consists in causing current variation in a circuit including the electrolyte arising from polarisation or the formation of an insulating gas film to induce a current of relatively high tension and applying the high-tension current thus produced to the surfaces to be depolarised. The apparatus comprises a transformer consisting of a low-tension primary winding in series with the current source and the electrodes, and a high-tension secondary winding inductively related to the primary and connected with the electrodes so that current variation in the primary induces in the secondary a current which reduces the polarisation between the electrodes. In the drawing A is the electrolytic cell and B the source of current. C is the transformer, while D D are choke coils. The rapid fall in the strength of the current through the primary winding E of the transformer, caused by polarisation in the cell, produces a high-tension counter-current in the secondary which repels the gas particles from the electrode.—*May 31st*, 1923.

TELEGRAPHS AND TELEPHONES.

197,854. February 27th, 1922.—IMPROVEMENTS IN OR RELATING TO INTERVALVE TRANSFORMERS FOR USE IN WIRELESS RECEIVING APPARATUS, C. F. Elwell, Limited, of Craven House, Kingsway, London; and Brenchley Ernest George Mittell, of 43, Handen-road, Lee, Kent.

This invention relates to intervalve and telephone transformers for use in wireless receiving apparatus employing one or more thermionic valves. The transformer box or casing—preferably the lid thereof—is provided with a holder A for a thermionic valve, the sockets of which holder are electrically connected with the appropriate parts of the transformer. The holder and the lid constitute a self-contained unit with the transformer, in contradistinction to the existing arrangements in which the valve holder is carried by a panel distinct and separate from the transformer. These arrangements necessitate the employment

N°197,854



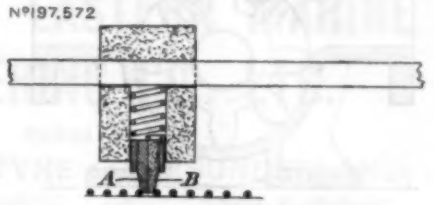
of wiring between the sockets of the valve holder and the appropriate parts of the transformer, and this wiring has been found to lead to a certain amount of inter-action between the circuits of adjacent valves. The omission of such wiring in the present invention not only provides a more compact apparatus than heretofore, but reduces the inter-action between the circuits of adjacent valves.—*May 24th*, 1923.

SWITCHGEAR.

197,572. June 22nd, 1922.—SLIDING CONTACTS FOR INDUCTANCES, E. Mallett, 31, Engayne-gardens, Upminster; and R. Marx, 9, Clifton-street, Finsbury-square, London, E.C. 2.

This sliding contact is made of two pieces, one half A being of

N°197,572



metal and the other half B of insulating material. It is thus impossible for the contact to short circuit the turns of the coil along which it is slid.—*May 17th*, 1923.

TURBINE MACHINERY.

197,873. July 18th, 1922.—MIXED FLOW STEAM TURBINES, *Metropolitan-Vickers Electrical Company, Limited, 4, Central-buildings, Westminster.*

In this turbine steam coming from the axial flow part A,

N°197,873

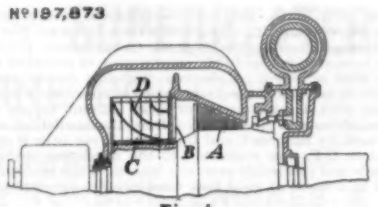


Fig. 1.

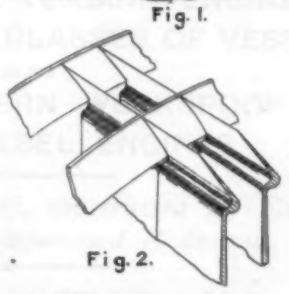


Fig. 2.

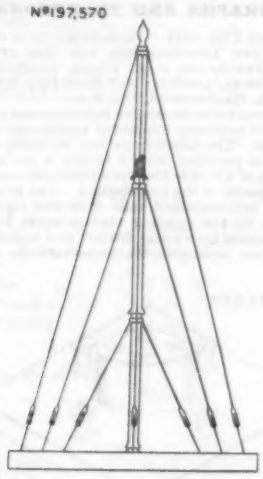
Fig. 1, of the turbine passes through fixed guide blades B and thence to the wide blades C, in which it is deflected to a radial direction by the plates D. The wide blades have the form shown

in Fig. 2, so that their discharge openings point more or less tangentially. It is said that these blades may be drop-forged in one piece.—*May 24th*, 1923.

TRANSMISSION OF POWER.

197,370. June 21st, 1922.—MASTS FOR TRANSMISSION LINES, G. B. R. Pimm, 72, Queen-square, Bristol.

In this specification claim is made for a pole or mast composed of two or more sections arranged on a common base on which the lowest section is mounted, each section consisting of three or more stay or tie rods in tension and a strut in compression, the struts being mounted successively one on the other, each strut

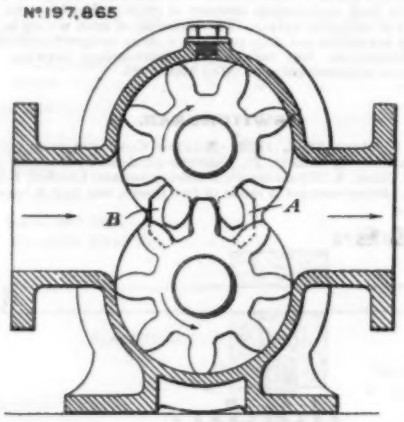


being held in position by three or more stays or tie rods attached to its upper end and to the common base, and by its connection to the strut next below it (or in the lowest section, to the common base), by a joint preventing independent movement of the struts, but providing flexibility in the mast. The drawing is self-explanatory.—*May 17th*, 1923.

PUMPING AND BLOWING MACHINERY.

197,865. July 10th, 1922.—GEAR PUMPS, G. J. Stevens, 25, Eastlake-road, London, S.E. 5.

The inventor says that with the gear type of pump there is

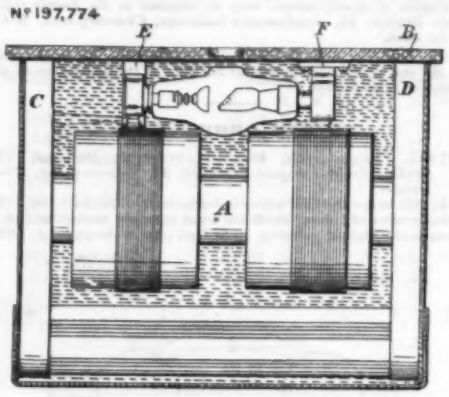


considerable loss owing to the fluid being pocketed or locked between the teeth on the discharge side and also owing to the creation of a partial vacuum between the teeth on the entrance side of the pump, the liquid in the pockets having to be forced out from between the teeth when they come into full mesh, thus causing some loss of power on both sides of the pump. He thus provides recesses A and B in the end plates of the casing which provide connection from the pockets between the teeth to the outlet and inlet respectively.—*May 24th*, 1923.

MISCELLANEOUS.

197,774. March 6th, 1922.—IMPROVEMENTS IN AND RELATING TO OIL-COOLED ELECTRON DISCHARGE DEVICES, *The British Thomson-Houston Company*, 83, *Cannon-street, E.C.* 4.

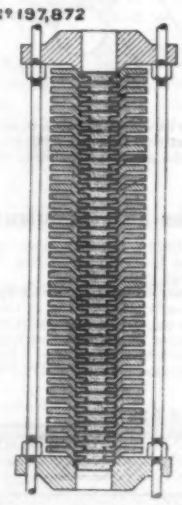
This invention relates to the construction of electrical devices of the kind in which an electron discharge device, such, for example, as an X-ray tube, is immersed in oil within a container, together with a transformer, or other current supply device. The transformer A is supported from the insulating cover B of the tank by hangers C and D and the X-ray tube is mounted in holders E F, also connected to the insulating cover. The side walls and preferably even the bottom of the enclosing tank consist of a metal of good heat conductivity, for example, aluminium or copper. The side walls are proportioned to conduct the heat communicated to the oil surrounding the X-ray tube at a sufficient rate to cause the temperature of the oil and the tank to be equalised. As a result of the effective distribution of the heat by the walls of the container circulatory currents are set up in the oil and local overheating is prevented. Apparently when the outfit is operated in an upright position



circulatory currents are set up adjacent the X-ray tube, the heated oil immediately surrounding the tube rising and flowing outwardly against the side walls. Here the heated oil gives up some of its heat to the walls, which conduct the heat downwardly and set up a secondary circulation. As a result the heat is distributed and local overheating is prevented.—*May 24th*, 1923.

197,872. July 14th, 1922.—CATALYTIC APPARATUS, I. W. Cederberg, 16, Landshuterstrasse, Berlin, Germany; and H. M. Bäckström, Djursholm, Sweden.

This catalyst chamber is intended for exothermic actions, such as the oxidation of ammonia, and is intended to assure that the gases cannot pass through the apparatus without coming into contact with the catalyst. It is built up of a number of plates, which are fitted together on conical seatings and have



wide flanges for the dissipation of the surplus heat. The whole series is bolted together as shown. The catalyst—pumice stone with finely divided platinum deposited on it—is made up as discs which rest in openings in the centre of the plates. In the event of gas escaping past the sides of the discs it is deflected across the upper face of the disc by the flange on the plate above.—*May 24th*, 1923.

SUMMER VACATION LECTURES AT GRENOBLE.—A summer vacation course of lectures on water power, its development, transmission and utilisation, will be held at Grenoble from Tuesday, August 7th, to September 7th next. This course of lectures was started in the summer of 1920 to give facilities to British engineers and engineering students for the study of hydraulic power and power transmission. Grenoble is situated in the centre of a district where energetic water power development and electro-chemical activities have taken place for the last thirty years. Those who have had instruction in French at public schools or in higher secondary schools should find no difficulty in following the lectures, which are given in French. A preparatory course can be attended by those who desire it, beginning on July 1st. The lectures cover the subject from the watershed estimates to the economic distribution of the power developed. Visits are arranged to some of the many installations in the neighbourhood which are in operation or under construction. The lectures are thoroughly practical in character and are given by professors with experience in the district. Further particulars may be obtained by application to the Office National des Universités Françaises, 50, Russell-square, London, W.C. 1.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

SOCIETE DES INGENIEURS CIVILS DE FRANCE.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Paper, "The Port of Rouen and the Lower Seine," by Monsieur M. Barillon. 8.30 p.m.

MONDAY, JULY 2ND.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. General meeting of members. 5 p.m.

MONDAY TO WEDNESDAY, JULY 2ND TO 11TH.

INTERNATIONAL NAVIGATION CONGRESS.—At the Institution of Civil Engineers, Great George-street, S.W. 1. For programme see page 588.

TUESDAY TO SATURDAY, JULY 3RD TO 7TH.

ROYAL AGRICULTURAL SOCIETY'S SHOW at Newcastle-on-Tyne.

WEDNESDAY AND THURSDAY, JULY 4TH AND 5TH.

BRITISH WATERWORKS ASSOCIATION.—Summer meeting at Cardiff. For programme see page 565.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE Council of the University of Sheffield has appointed Mr. P. J. Daniell, M.A., Sc.D. (Cambridge), to the Town Trust Chair of Mathematics.

MESSRS. KNIGHT AND SMITH inform us that they have moved their office from Dunedin House, Basinghall-avenue, to 146, Bishopsgate, London, E.C. 2.

MR. FRANK H. BRUNT, M. Inst. C.E., asks us to state that he has removed his office from 121, Victoria-street, to 17, Victoria-street, but that his telephone number is Victoria 8477 as heretofore.

MESSRS. WM. SANDERS AND CO., switchgear manufacturers, Wednesbury, have transferred their London showrooms from 90, Charing Cross-road, to Palace House, 128, Shaftesbury-avenue. The telephone number remains the same, viz., Gerrard 8984.

WE are asked to state that Mr. Kenneth R. Stuart has been appointed manager of the Sheffield branch of Crompton and Co., Limited, at 8, Norfolk-row, Sheffield, the area comprising parts of Derbyshire, South Yorkshire, Leicestershire, and Nottinghamshire.

MR. ROLAND DUNKERLEY, F.C.W.A., chief works accountant of the Metropolitan-Vickers Electrical Company, Limited, Old Trafford, Manchester, has been elected chairman of the Council of the Institute of Cost and Works Accountants, London, for the ensuing year.

NOTT, BRODIE AND CO., Limited, ask us to state that they have moved their head office from 19, Clare-street, Bristol, to 60, Queen-square, Bristol. Their telephone number and telegraphic address will remain as at present, namely, Bristol 4182 and "Concrete, Bristol" respectively.

THE UNITED STEEL COMPANIES, Limited, will remove their London office from 15, Victoria-street, Westminster, S.W. 1, to St. Stephen's House, Victoria Embankment, Westminster, S.W. 1, on July 6th next. The undermentioned firms of the United Steel Companies, Limited, will also be found at the same address:—Steel, Peech and Tozer, Limited; Workington Iron and Steel Branch of the United Steel Companies, Limited; Frodingham Iron and Steel Company, Limited; Distington Hematite Iron Company, Limited; Samuel Fox and Co., Limited; Martino Steel and Metal Company, Limited; and Daniel Doncaster and Sons, Limited.

CONTRACTS.

THE Huddersfield Corporation has placed a contract with the English Electric Company, Limited, for ten complete top-covered tramcars, including trucks and the electrical equipment comprising D.K. 30 motors and D.B. 1 K. 3 controllers.

STANDARD ROLLED STEEL SECTIONS.—The British Engineering Standards Association has recently issued its Publication No. 6, 1923, "Dimensions and Properties of British Standard Rolled Steel Sections for Structural Purposes." It may be recalled that, to meet the urgent requests of designers, the Association published the figures regarding channels and beams as an advance measure in August, 1921 (Report No. 4, 1921), and they are incorporated in the new report. The book is divided into two portions, the first giving the dimensions and properties in British units, the second their metric equivalents, attention being called to the fact that in the case of small discrepancies between the two portions the British measures are to be regarded as the standard. So far as the data relating to equal angles, unequal angles and tee bars, for which there is more than one standard thickness of section, are concerned, only the properties of the minimum thicknesses are printed, but the Association announces that the values for the other thicknesses calculated by approximate formulæ, which it is also intended to publish, will be issued in a subsequent edition. The new report may be obtained from the offices of the B.E.S.A., 28, Victoria-street, S.W. 1, price 1s. 3d. post free.

END OF VOL. CXXXV.

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BALING PRESS, One New Hydraulic, Capacity 300 tons; cost about £4500; offers invited.—The LIQUIDATOR, Scottish Mesopotamia Corporation Ltd., 31, George-street, Edinburgh. 2883 o

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HACK SAW CUTTING-OFF MACHINE, capable of cutting off 30in. square ingots.
All machines are little used.
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CROSSLEY GAS ENGINE, 70 B.H.P., FOR SALE; also comparatively new 60 B.H.P. GARDNER. Both may be seen at work.—E. T. SHELLEY, Ltd., Aston Brook-street, Birmingham. 2874 o

CYLINDER BORING.—FOR SALE at Low Price, Good DUPLEX HORIZONTAL CYLINDER BORING MACHINE, designed to bore two cylinders simultaneously from 8in. to 16in. diameter; complete with boring bars, overhead gear, &c.—JOHN H. RIDDEL, Ltd., 40, St. Enoch-square, Glasgow. 2012 o

DYNAMOMETER, Heenan and Froude, size D.P. 4, new; half makers' price.
SUN-LANE WORKS,
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BELLISS AND MORCOM
ENGINES
are in very good order, but must be cleared quickly; hence the practically "scrap" prices now quoted.
One 1500 H.P. Triple-expansion Engine, £525.
Two 650 H.P. Ditto, £355 each.
Two 650 H.P. Tandem Compound Engines, £255 each.
Also One Nearly New 1500 K.W. High-pressure Turbo-driven Alternator, £475.
One 100 K.W. Low-pressure Turbo-driven Set, £435.
Inspection in London.
Full details from THOS. W. WARD, Ltd., Silvertown, London, E. 2769 o

ENGINEERS AND SURVEYORS.—FOR SALE at half cost, ONE New Complete OUTFIT of the "KINKEAD" PATENT ALIGNING and LEVELLING APPARATUS. Is also suitable for foundation work, general machinery and outdoor surveying. All complete with working instructions, &c.—Full particulars on application to AITKEN and CO., Britannic House, Park-circus, Glasgow. P7609 o

FOR SALE AT LOW PRICES.—
Superior 400 K.W. Howden-Siemens GENERATING SET, 230 volts D.C.
ONE High-class HORIZONTAL COMPOUND CORLISS ENGINE, belt driven, 200 H.P.
ONE Powerful Steam-driven COMPOUND HORIZONTAL HYDRAULIC PUMPING ENGINE, capacity 300 gallons per minute; makers, Sir Wm. Arrol and Co., Ltd.
ONE Babcock and Wilcox WATER-TUBE BOILER (Land Type), heating surface 3467 square feet, 200 lb. w.p., fitted with mechanical stokers, superheaters, &c.
TWO Babcock and Wilcox WATER-TUBE BOILERS (Land Type), each 1827 square feet heating surface, 200 lb. w.p., fitted with mechanical stokers, superheater, &c.
TWO Very Fine Engine-driven CENTRIFUGAL PUMPS, by Drysdale, capacity 1250 gallons per minute.
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THREE VERTICAL BOILERS, 11ft. by 4ft., 8ft. 6in. by 4ft., and 8ft. by 3ft. 6in. respectively; will re-insure 80 lb. pressure.
TWO RADIAL ARM DRILLING MACHINES, with arms 6ft. 6in. and 4ft. 6in. respectively.
ONE 15in. centre LATHE, with 20ft. gap bed, by Swift.
ONE 64in. centre LATHE, by Swift, with 8ft. 6in. gap bed, hollow spindle.
ONE MILLING MACHINE, with 30in. gap, by Parkes, Griffiths.
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New list of New and Second-hand Machinery free on application. Ex.

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285 Feet 16in. Steam, flanged.
2500 Feet 12in. Ditto.
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20,000 Feet 6in. Water, screwed.
21,000 Feet 5in. Ditto.
50,000 Feet 4in. Ditto.
120,000 Feet 3in. Steam, screwed in 7ft. lengths.
Also smaller sizes.
50,000 Feet 4in. Steel with loose flanges.
11,000 Feet 6in. and 8in. Weldless Steel Spigot and Faucet.
We can supply Unused Pipe Fittings for above more cheaply than anyone else. Write for our list before ordering.
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FOR SALE, TWO New 75 K.W. Brotherhood and Lindley COMPOUND ENGINES, direct coupled to Mather and Platt Three-phase GENERATORS, 220 volts, 50 periods. Low price.—WILLIAMS and SONS, 37, Queen Victoria-street, London. 2813 o

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DRAWING INSTRUMENTS, SECOND-HAND.
CLARKSON'S, 338, High Holborn, W.C.
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FOR SALE, TWO Babcock and Wilcox WATER-TUBE BOILERS, each 10,000 lb. capacity, fitted with superheaters and chain grate stokers; last working 200 lb. pressure.
ONE DITTO, 5000 lb. capacity, otherwise similar.
Very low price to clear quickly.
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FOR SALE, Two-stage Motor-driven AIR COMPRESSOR, by Alley and McLellan, capacity abt. 1200 cu. ft., direct coupled to 400-volts MOTOR.—WILLIAMS and SONS, 37, Queen Victoria-street, London. 2814 o

FOR SALE.—
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42in. "Gisholt" BORING and TURNING MILL, with 2 heads, full automatic.
5-Cwt. PNEUMATIC HAMMER, with Air Compressing Plant complete, by Pilkington.
MILLING MACHINE, heavy pattern, with table 18in. by 36in., by Haigh and Co., Oldham.
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16in. Foster TURRET LATHE, six tools, 5in. hollow spindle.
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For continuation of For Sale Advertisements see page 4.

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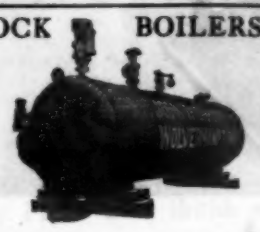

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4	30ft. by 9ft. 3in.	by 120 lbs. w.p.	Shop No. 6472/81
1	28ft. by 7ft. 6in.	by 120 lbs. w.p.	Shop No. 5761
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Continued from page 3.

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Height.	Diameter.	Pressure.	Maker.
14ft. 6in.	6ft. 6in.	100 lb.	Cochran.
14ft. 0in.	6ft. 0in.	100 lb.	Cochran.
14ft. 0in.	5ft. 6in.	100 lb.	Thompson.
12ft. 6in.	6ft. 0in.	100 lb.	Cochran.
12ft. 0in.	4ft. 6in.	80 lb.	
11ft. 9in.	5ft. 3in.	100 lb.	Cochran.
11ft. 3in.	5ft. 0in.	150 lb.	Cochran.
10ft. 6in.	4ft. 0in.	100 lb.	Coltman.
10ft. 3in.	4ft. 9in.	100 lb.	Cochran.
9ft. 6in.	8ft. 2in.	80 lb.	
8ft. 6in.	3ft. 9in.	120 lb.	Rushton.
8ft. 6in.	3ft. 6in.	80 lb.	Marshall
8ft. 0in.	4ft. 0in.	100 lb.	(New).
7ft. 6in.	3ft. 3in.	100 lb.	(New).
7ft. 0in.	3ft. 0in.	100 lb.	(New).
Three 6ft. 6in.	2ft. 6in.	100 lb.	(New).
Two 6ft. 0in.	2ft. 6in.	100 lb.	(New).

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SEVERAL 5-TON, varying from 23ft. to 40ft. span.

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All in good condition; can be inspected on the gantries in operation.

5ft. Arm Double-geared RADIAL DRILLING MACHINE, 3in. balanced spindle, T-slotted box bed, 3ft. 7in. by 3ft., by W. Muir and Co.

20in. stroke DOUBLE-HEADED SHAPING MACHINE, two T-slotted tables, 24in. by 18in. by 16in. deep, by J. Spencer and Co., Ltd.

VERTICAL BORING and TURNING MILL, table 4ft. 3in. diam., two tool-boxes on cross slide, by the Bridgeport Machine Tool Works, Ltd.

HORIZONTAL BORING MACHINE, spindle 3in. diam., T-slotted table, 3ft. 6in. by 1ft. 10in., by the Lucas Machine Tool Co.

200 TONS New Slightly Defective B.H. RAILS, British standard section, 85 lb. per yard.

Second-hand STEEL F.B. RAILS:—
150 Tons, 24 lb. per yard.
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FIVE LANCASHIRE BOILERS, 30ft. by 7ft. 6in., now insured at 180 lb. pressure.

SIX Very Good Dish-ended LANCASHIRE BOILERS, by Thompson, 30ft. by 8ft., re-insure for 140 lb. per sq. inch working pressure, ready for dispatch.

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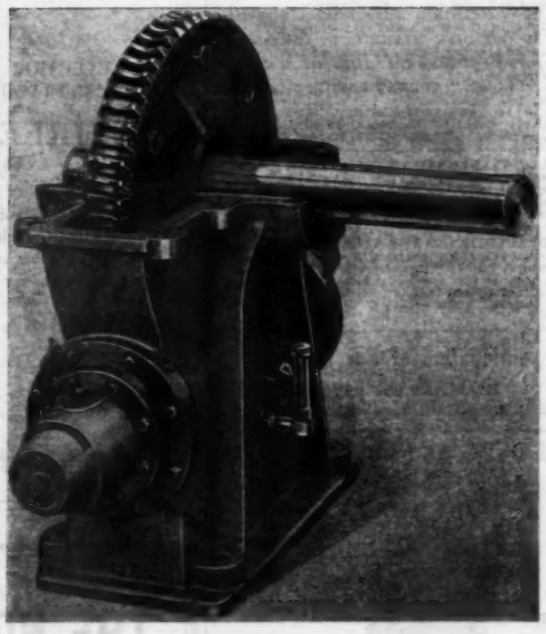

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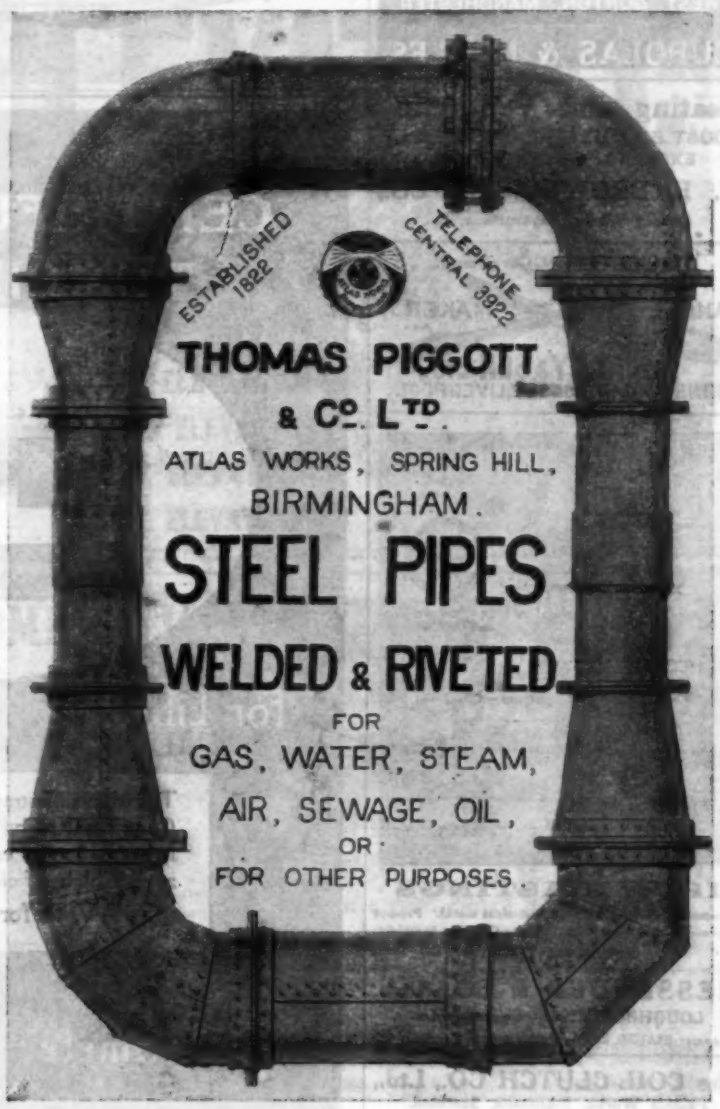

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29,000,000 Tons of Steel through Corrosion in 1920.

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Are supplied ready for application in the same way as ordinary paints, in Black, Red, Brown, Green or Grey.

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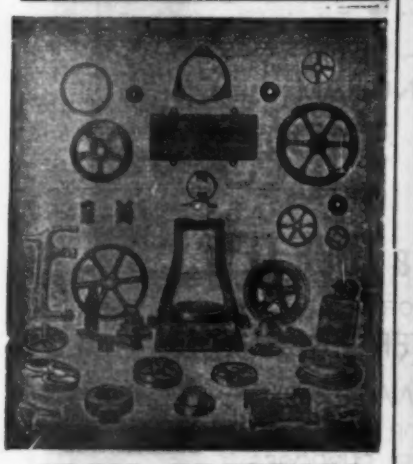

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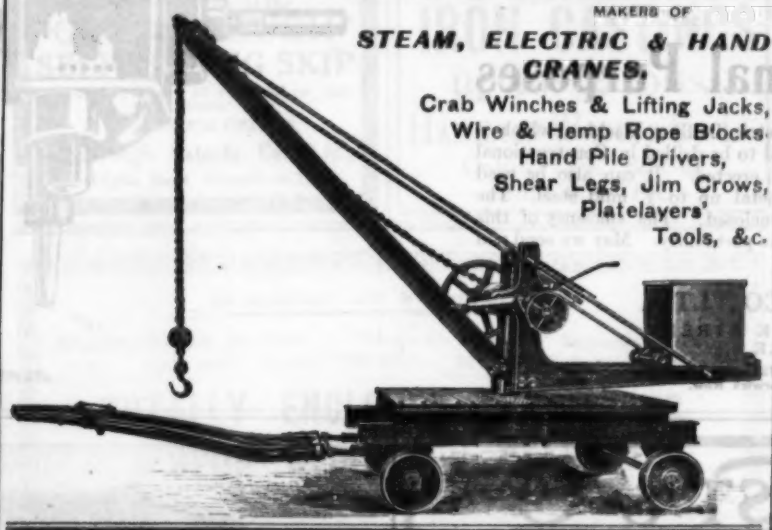

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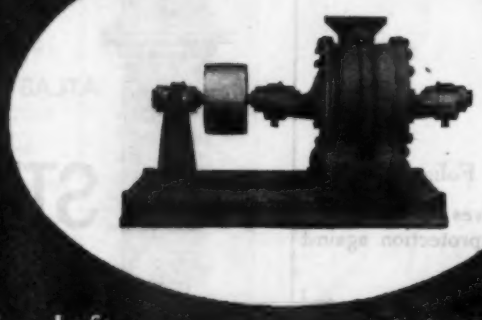

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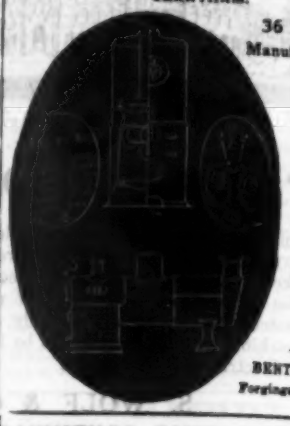

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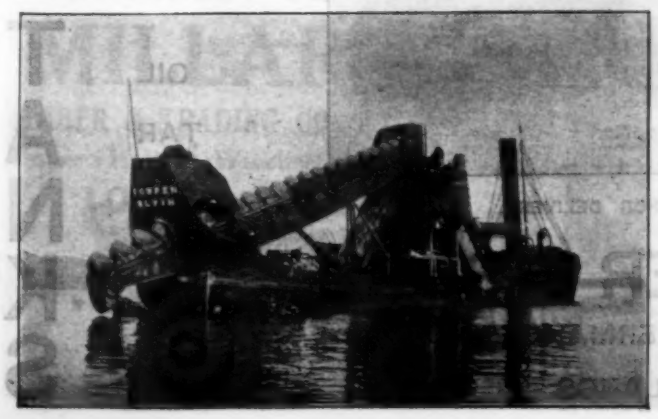

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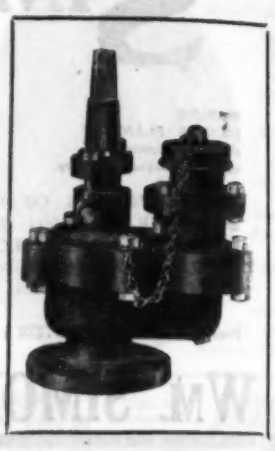

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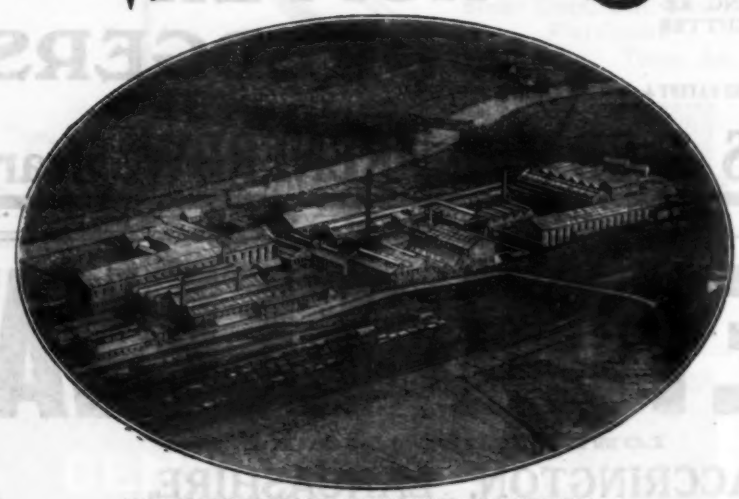

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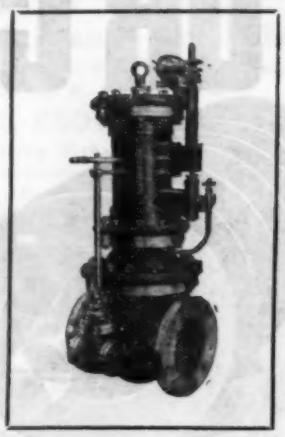

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HALIFAX, ENGLAND.
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PARSONS MOTOR Co. LTD. TOWN QUAY

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PERMAC JOINTS RESIST HIGHEST PRESSURES
PERMAC JOINTS DO NOT BLUST
EASILY REMOVED WHEN REQUIRED
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Worked by Hand, Power and Electric.
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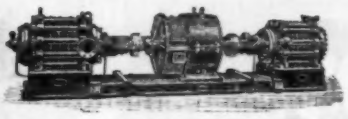

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See large Advertisement page 60, June 22nd.

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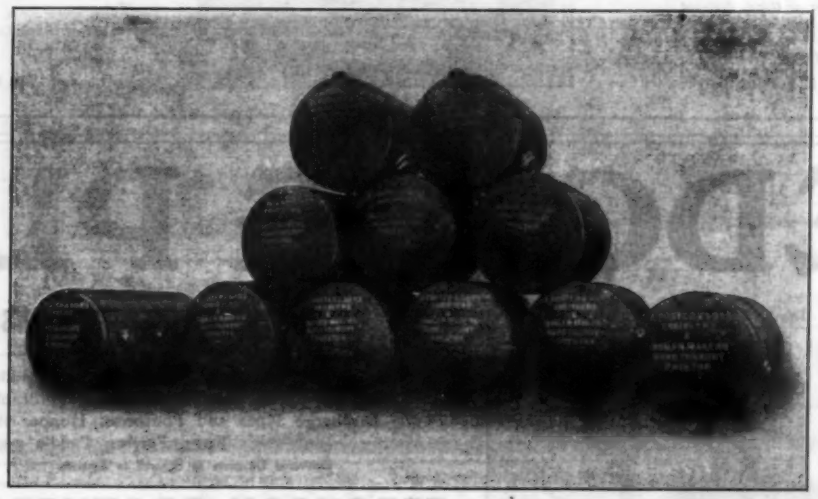

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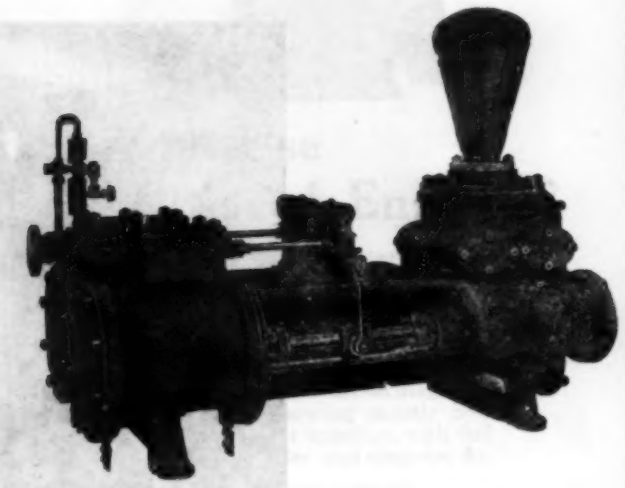

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411 A

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Large and rapid output—strength without excessive weight—economical both to buy and to run.

BRITISH MADE.

4 sizes and
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MACHINERY DEPT.,

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M 471

A Millars' 14L "Jaeger" Mixer used by Messrs. Logan & Hemingway in the construction of new loop line for Metropolitan Railway, Rickmansworth—Watford. Capacity, 14 cubic feet mixed—17 cubic feet unmixed materials. Automatic tipping water tank. Automatic loader. Weight 2¼ tons.

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without an economiser and without a superheater.

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Sole Concessionnaires for metallurgical furnace installations:—

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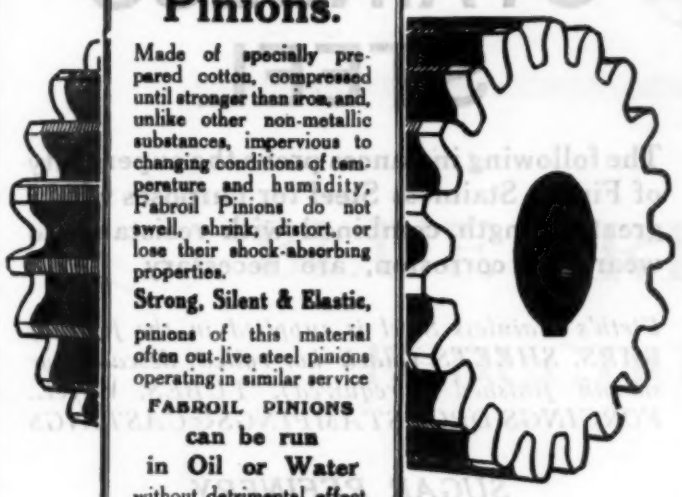
Pinions.



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Strong, Silent & Elastic,

pinions of this material often out-live steel pinions operating in similar service

FABROIL PINIONS
can be run in Oil or Water
without detrimental effect.

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Two Wheels can be pressed on at the same time.

DESIGNED FOR USE IN RAILWAY SHOPS, ENGINE & WAGON WORKS, TRAMWAY DEPOTS, ETC.

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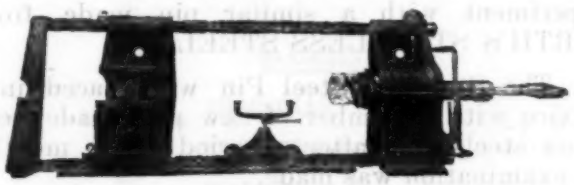

The Machine is complete with Drawback Gear, Travelling Carriage to Support the Wheel, Working Valve and Pressure Gauge.

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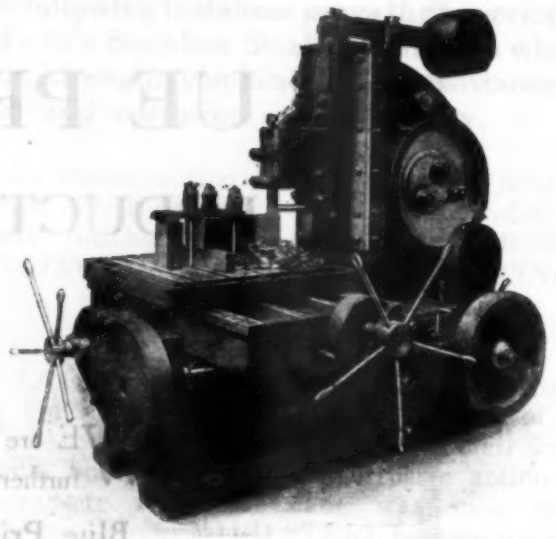

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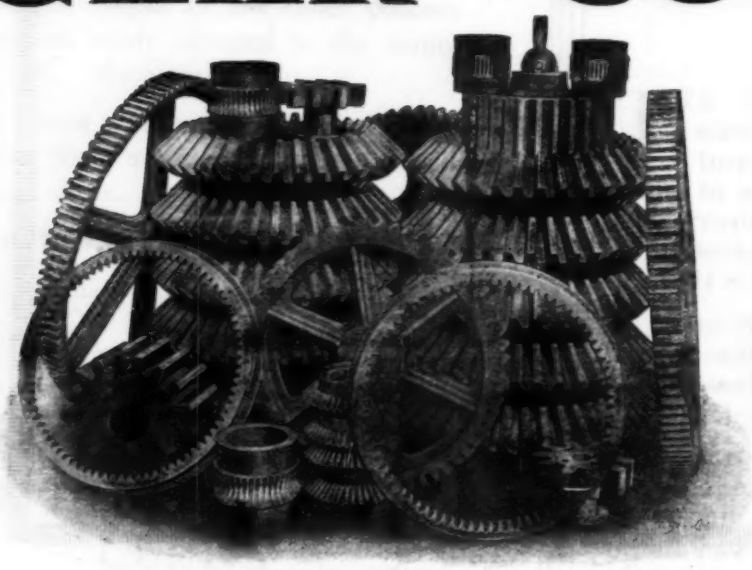

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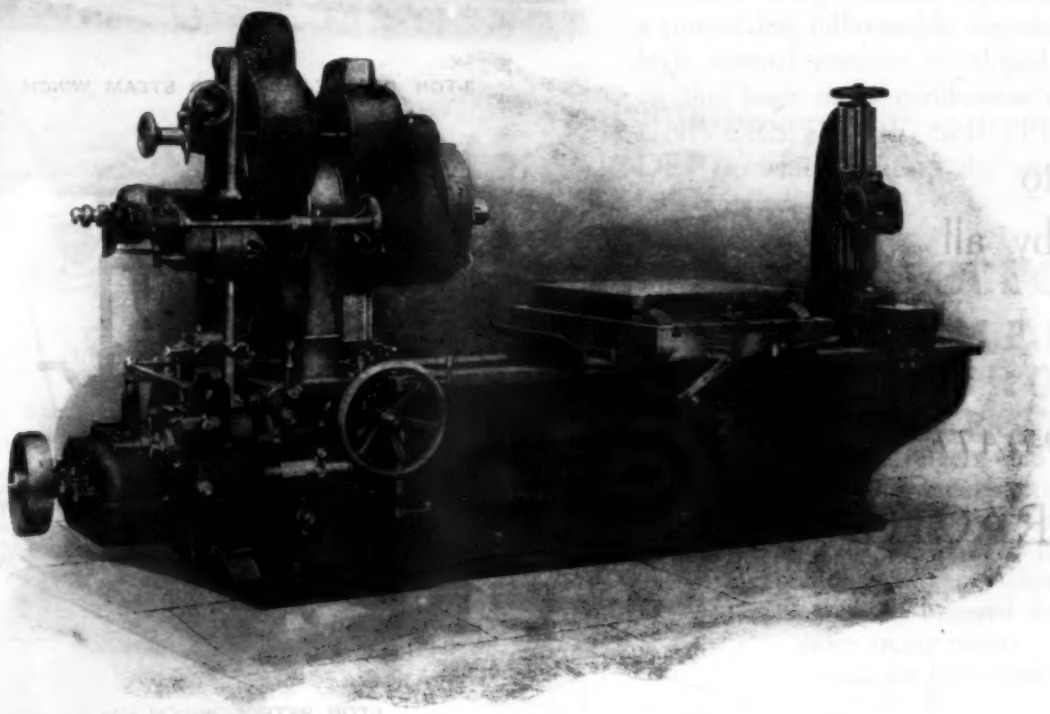

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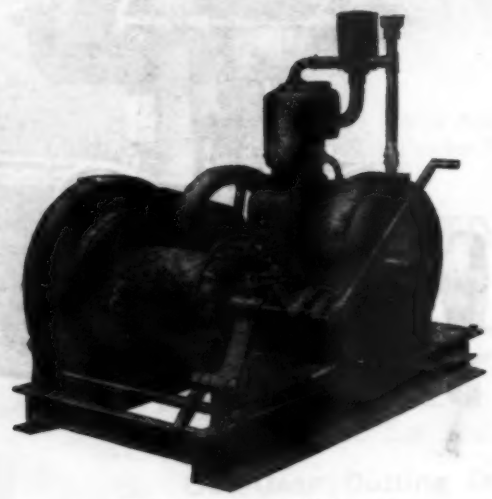

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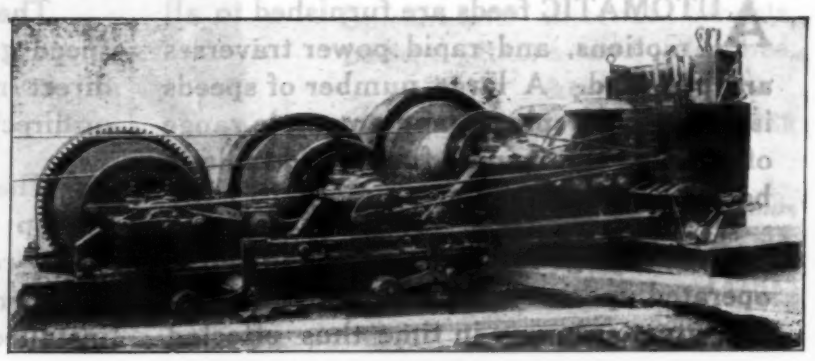

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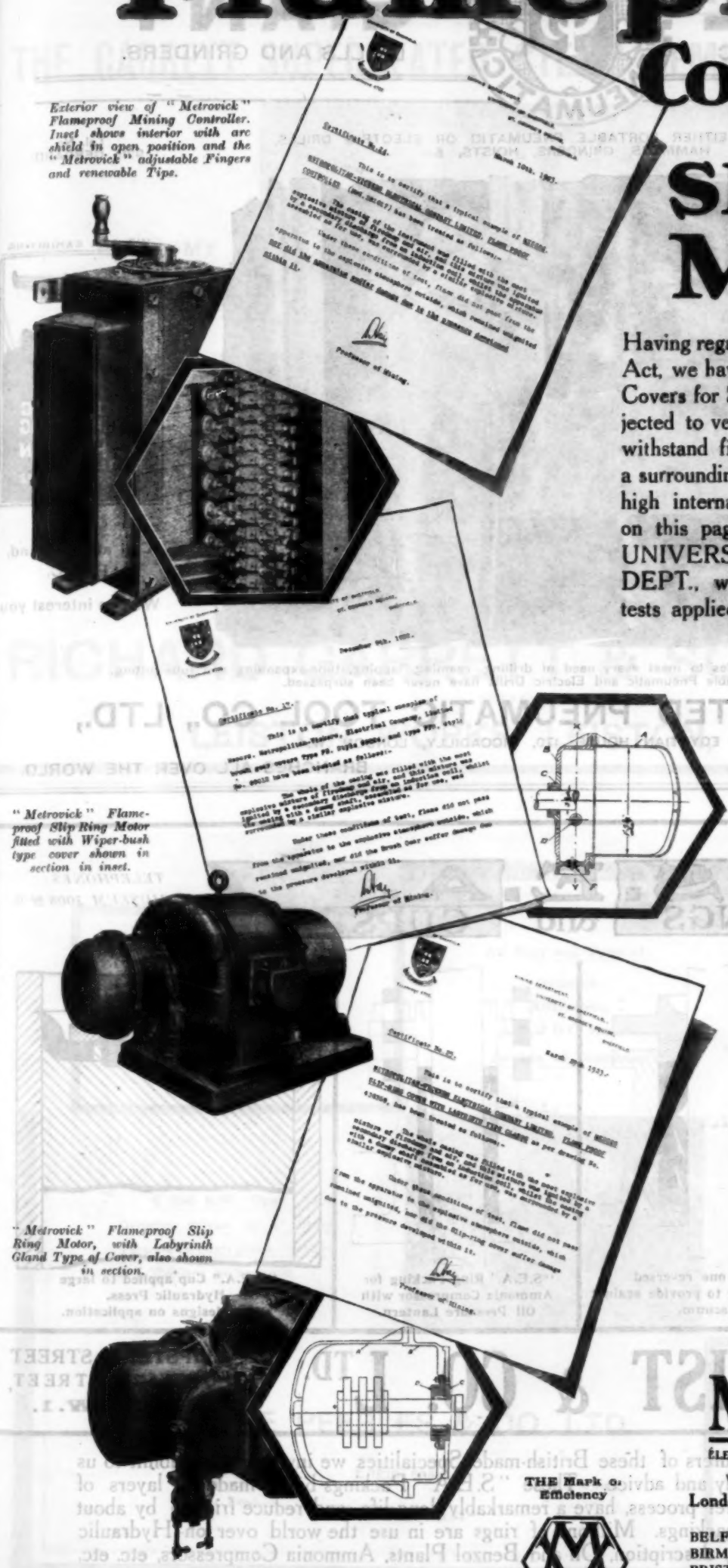
Flameproof Controllers and Slip Ring Motors



Exterior view of "Metrovick" Flameproof Mining Controller. Inset shows interior with arc shield in open position and the "Metrovick" adjustable Fingers and renewable Tips.

"Metrovick" Flameproof Slip Ring Motor fitted with Wiper-bush type cover shown in section in inset.

"Metrovick" Flameproof Slip Ring Motor, with Labyrinth Gland Type of Cover, also shown in section.

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"MetrovicK" FLAMEPROOF CONTROLLERS

are of the Air Break Type designed with contact fingers and contacts suitably rated for breaking without the use of quenching and cooling oil. This design avoids the danger that arises with oil immersed gear when the oil level is carelessly allowed to fall below one or more arcing points.

Send for Descriptive Leaflet E 64/4-1.

"MetrovicK" FLAMEPROOF SLIP RING MOTORS

are made with covers of two types: (*a*) the Wiper-Bush type for motors up to about 200 h.p. and (*b*) the Labyrinth Gland type for motors above 200 h.p. A photographic reproduction of each type is shown, together with the corresponding sectional drawing indicating the constructional details.

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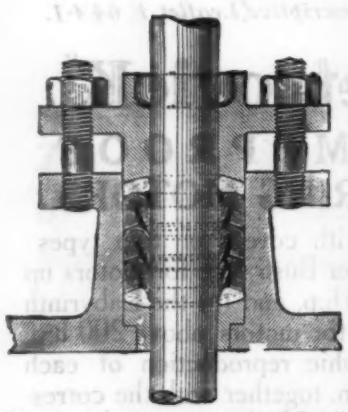
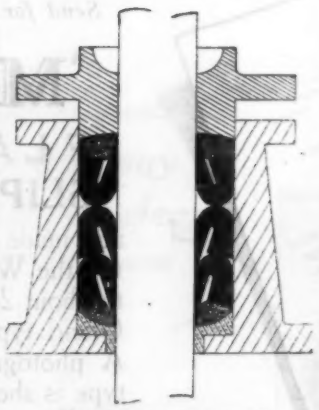
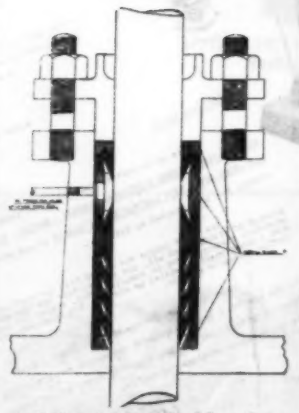


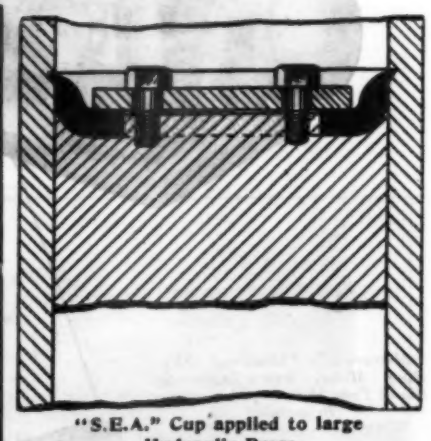
Standard Arrangement of "S.E.A." Rings with plastic Top and Neck Header Material.



Showing one reversed "S.E.A." Ring to provide against a vacuum.



"S.E.A." Ring Packing for Ammonia Compressor with Oil Pressure Lantern.



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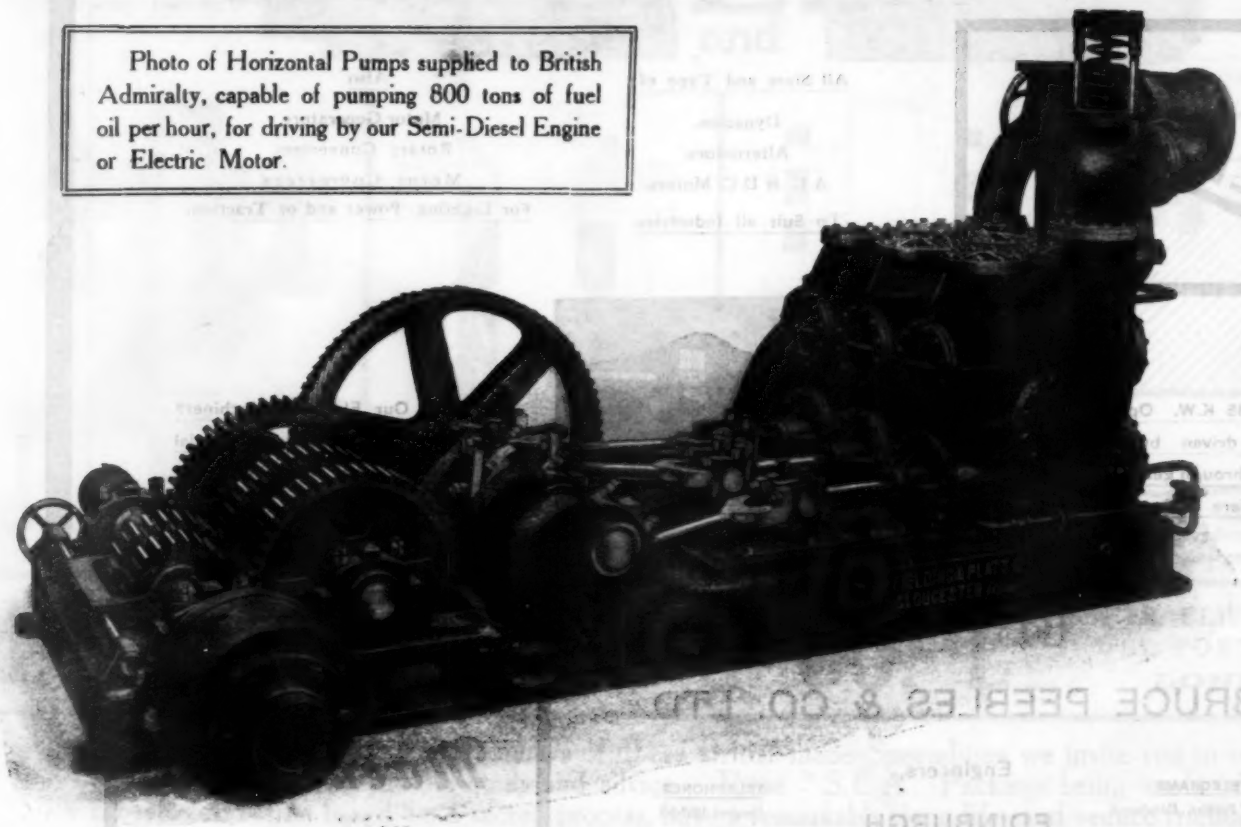

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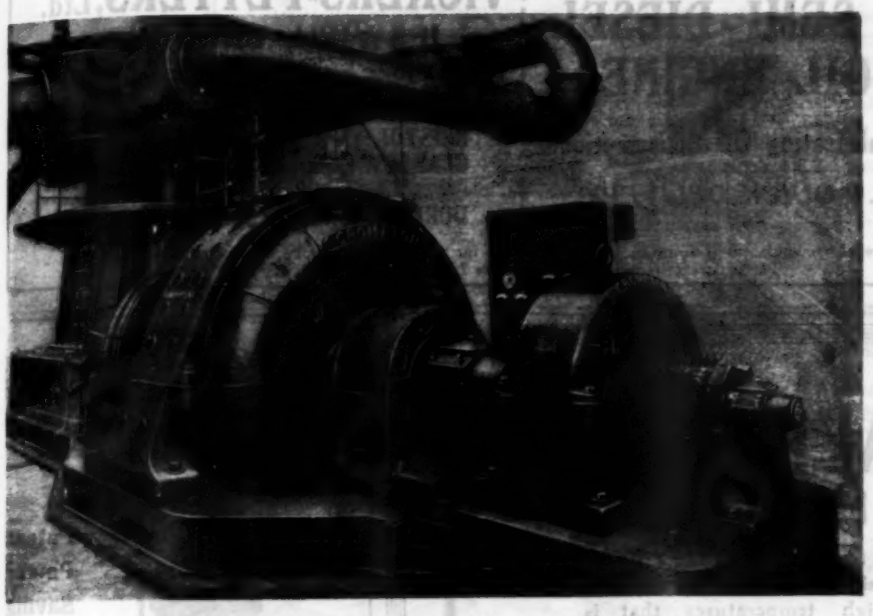

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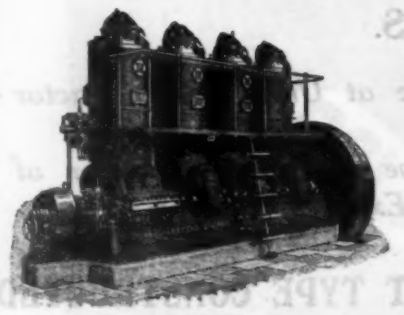

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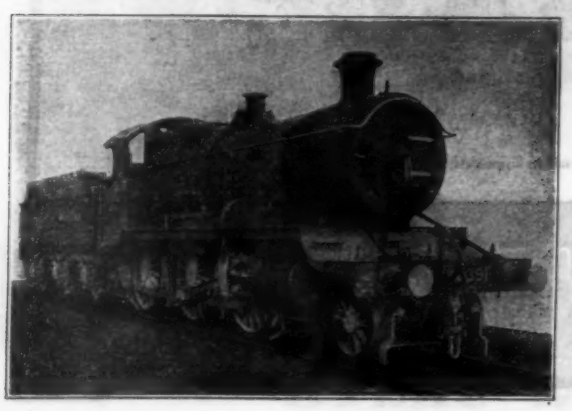

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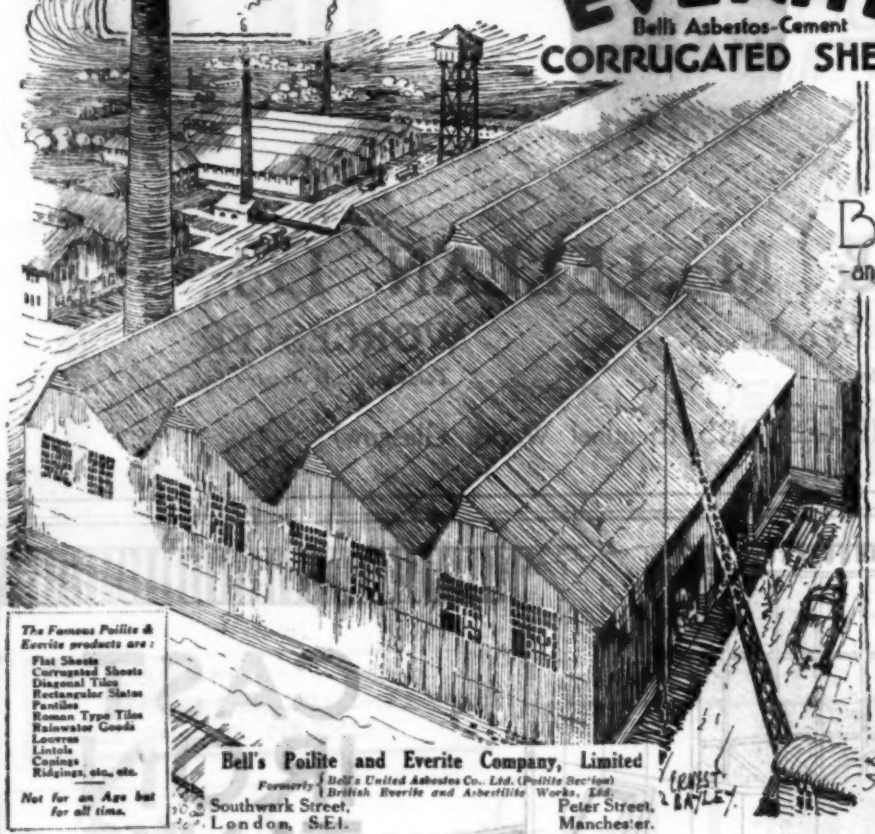

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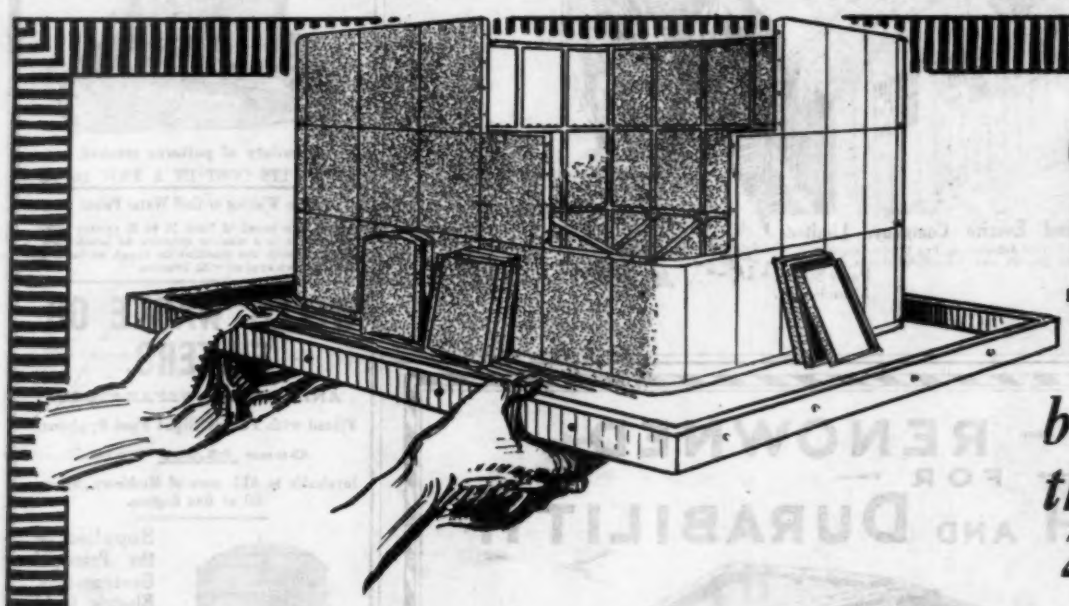

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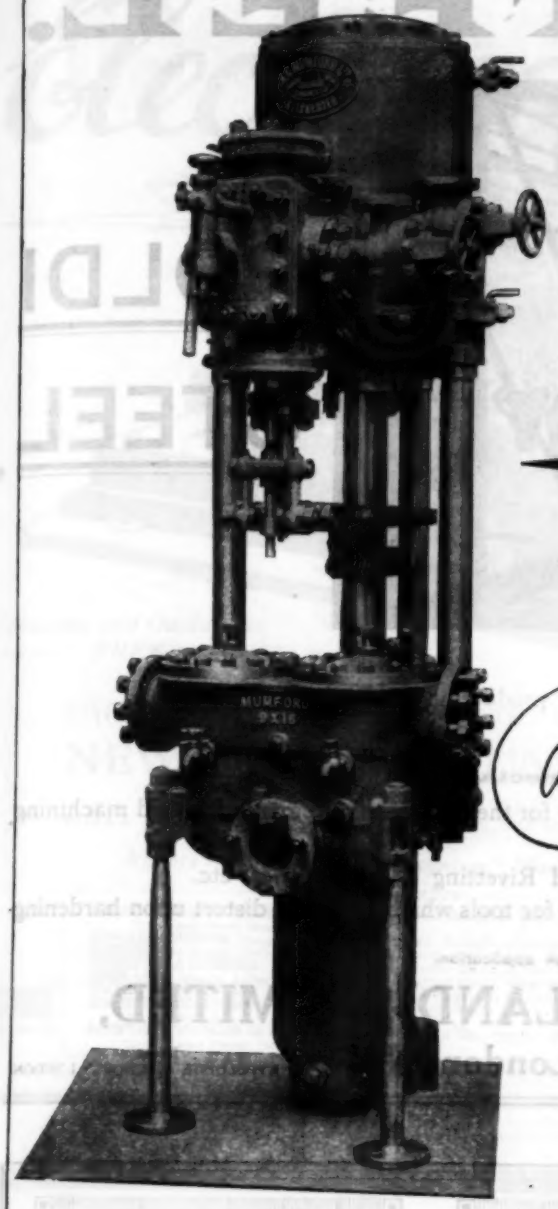

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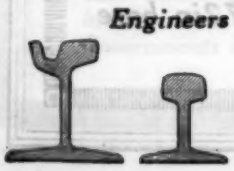

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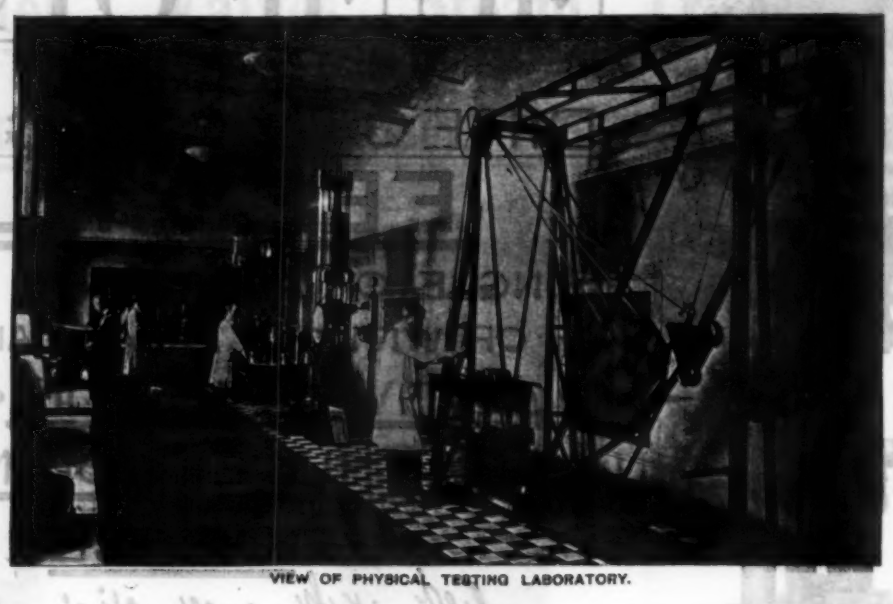

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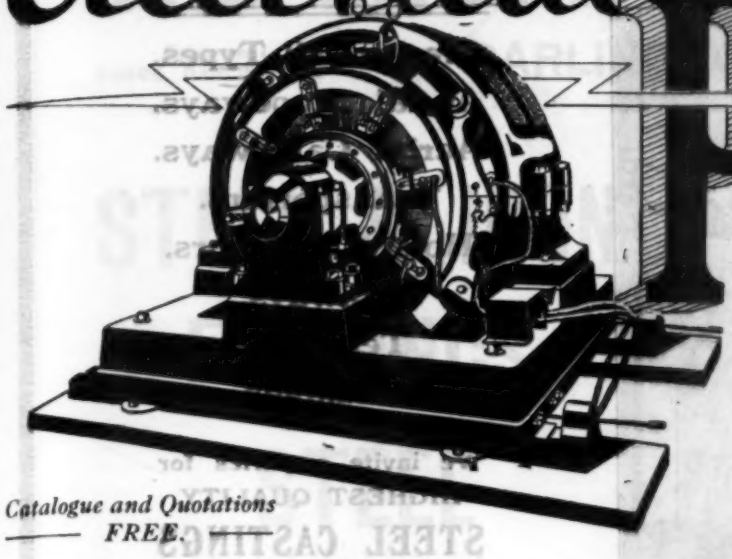

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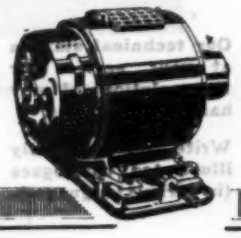

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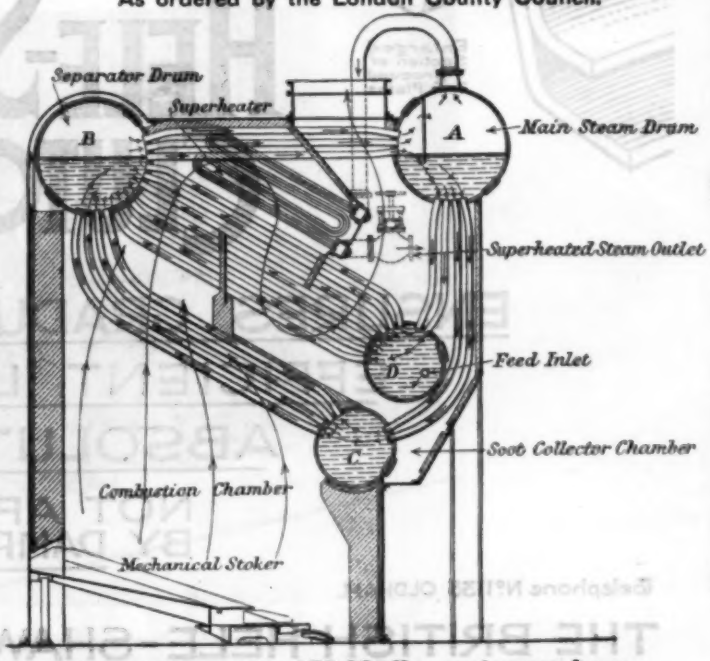

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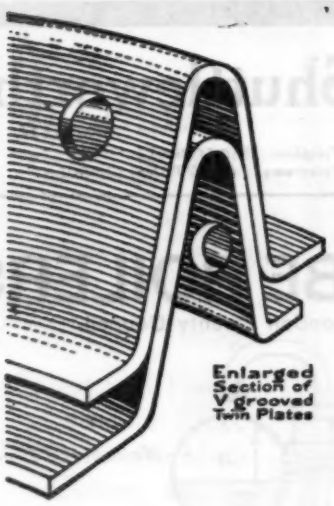

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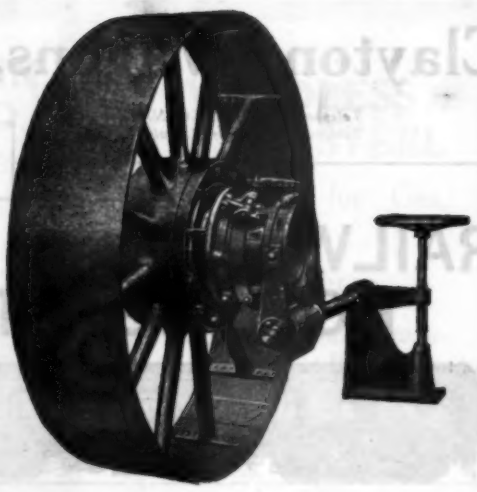

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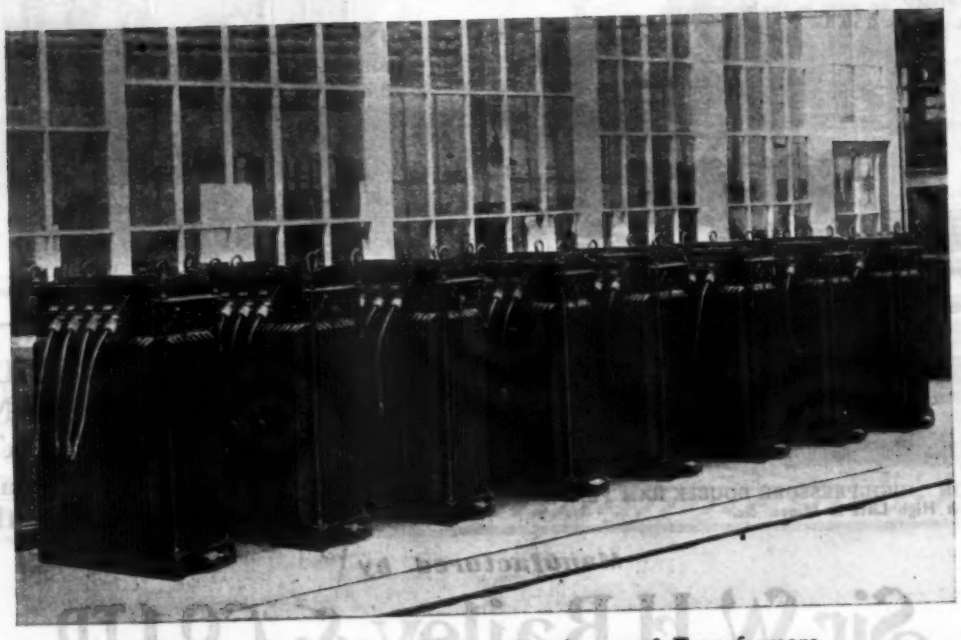

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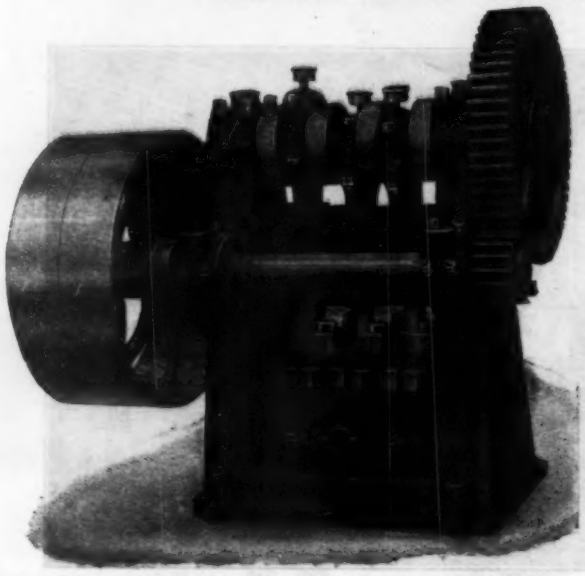

Fig. 7159.—BAILEY'S HYDRAULIC THREE-THROW PUMP.
For all pressures and capacities.

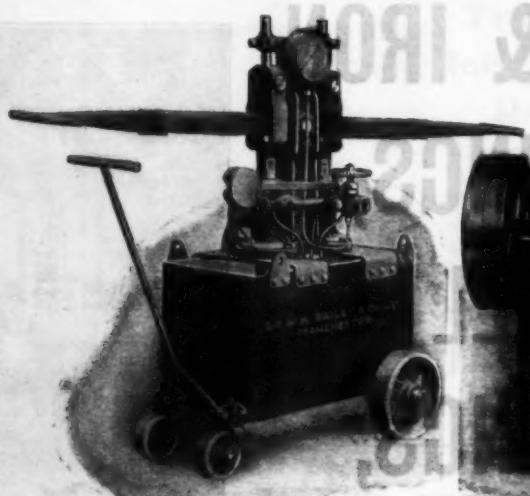

Fig. 5174.—"ADMIRALTY" TEST PUMP.
Of large capacity, for Pressures to 800 lbs.
For Testing Boilers, Piping Installations, &c.

Fig. 7161.—HYDRAULIC PUMP AND ACCUMULATOR.

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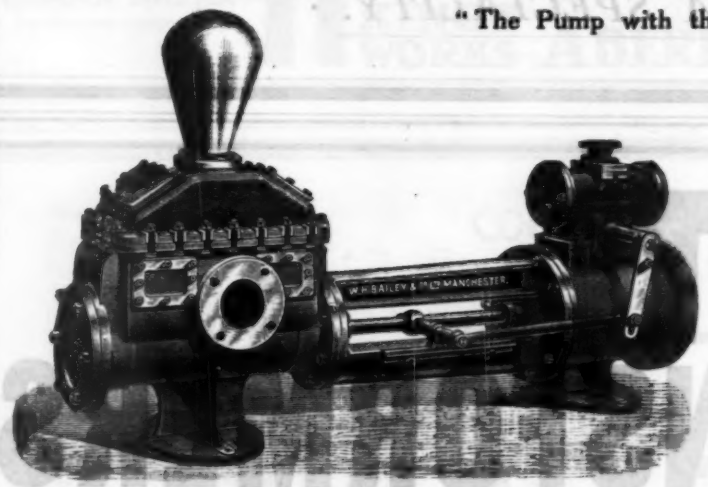

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"DAVIDSON" STEAM PUMP, as made in the larger sizes.
For Boiler Feeding, &c., to 150 lbs. Pressure.

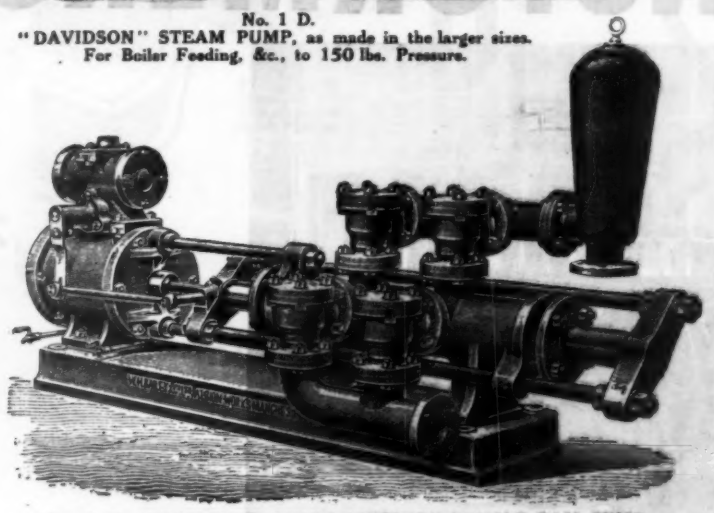

Fig. 6a D.—"DAVIDSON" HIGH-PRESSURE DOUBLE RAM PUMP.
For High Lifts in Mines, &c.

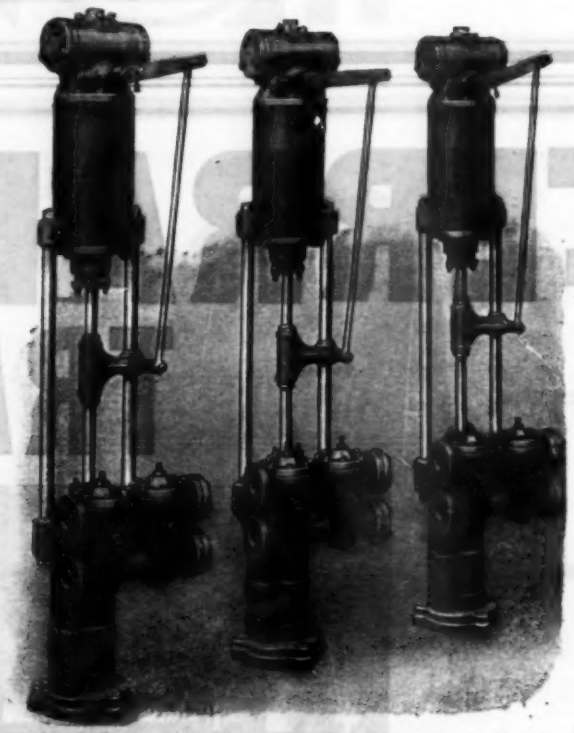

Fig. 50 D.—A Group of "Davidson" Patent Economical Boiler Feed Pumps

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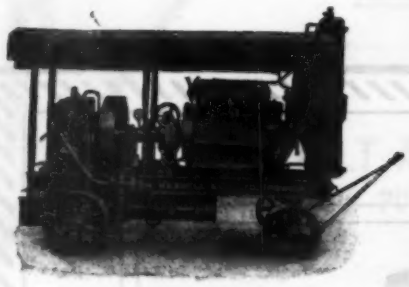

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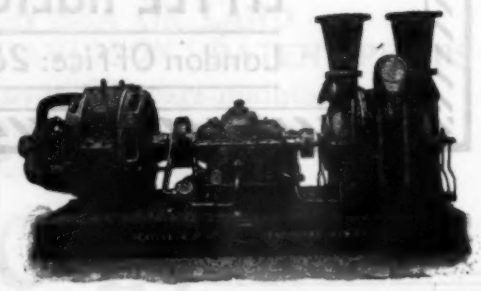

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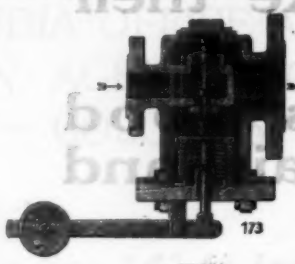

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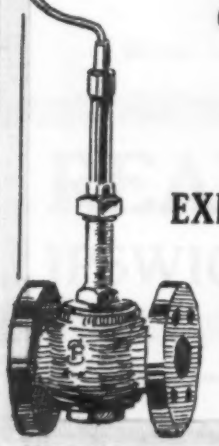

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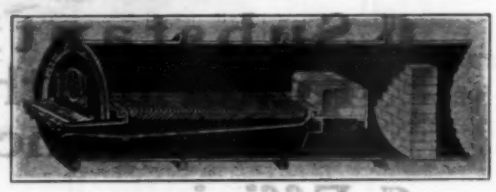

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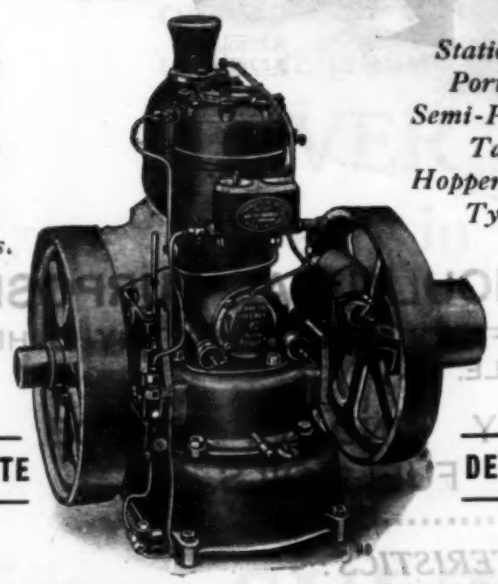

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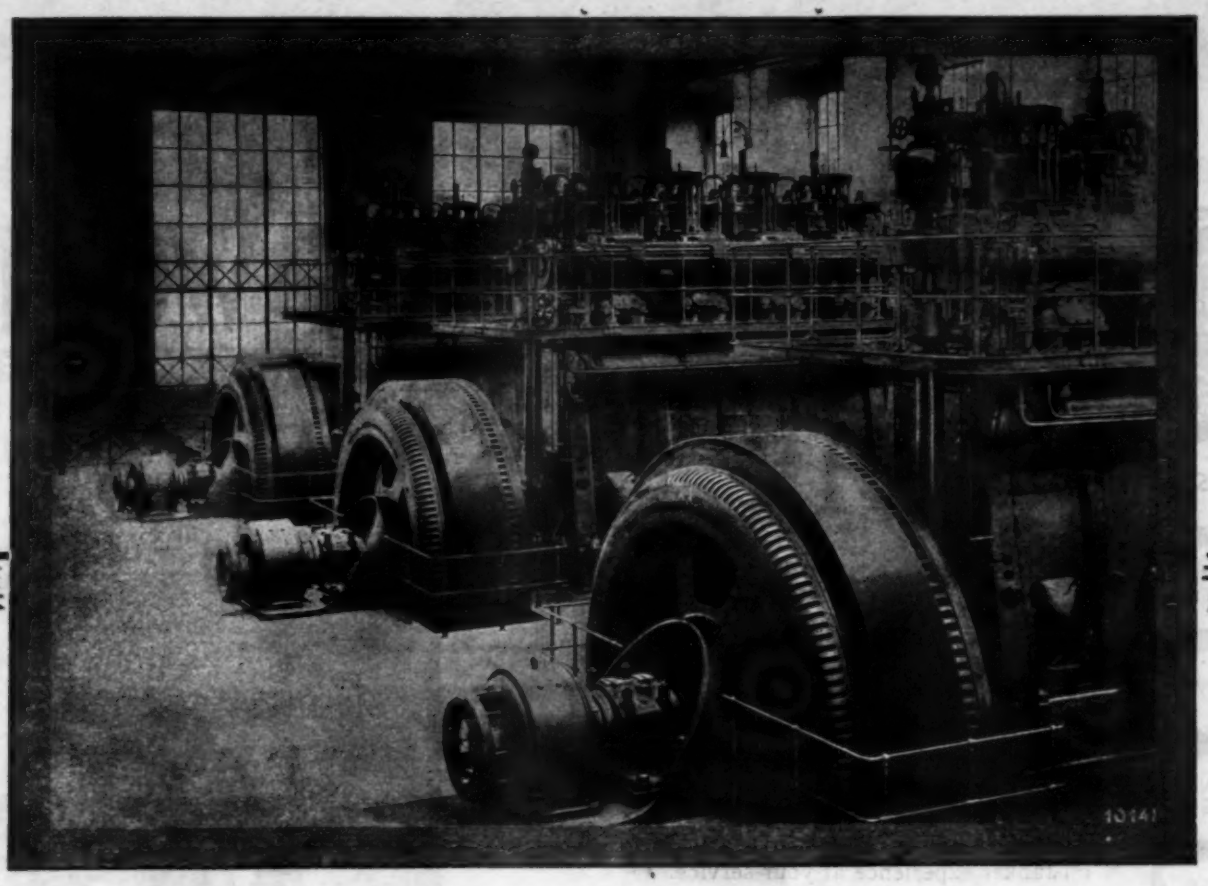

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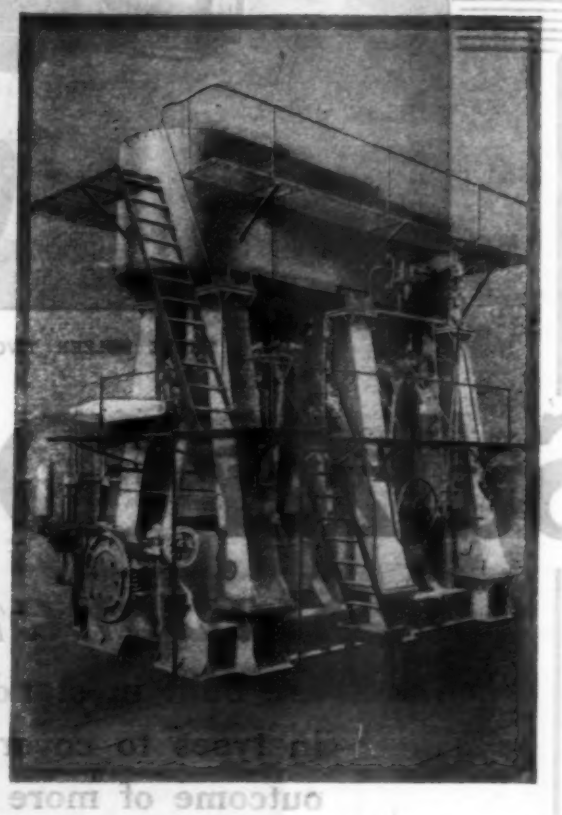

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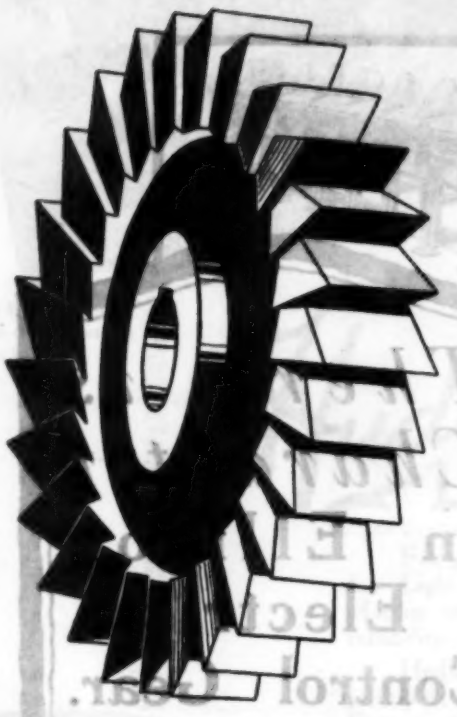

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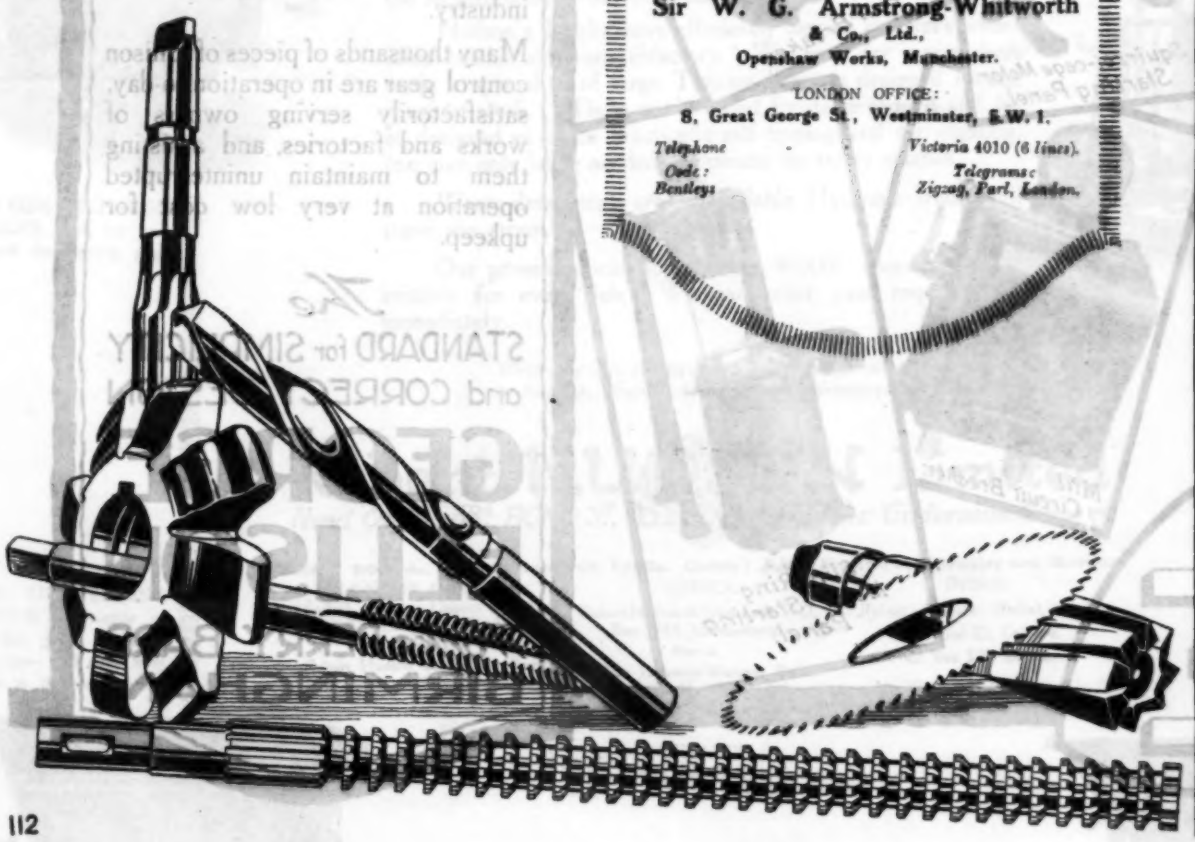

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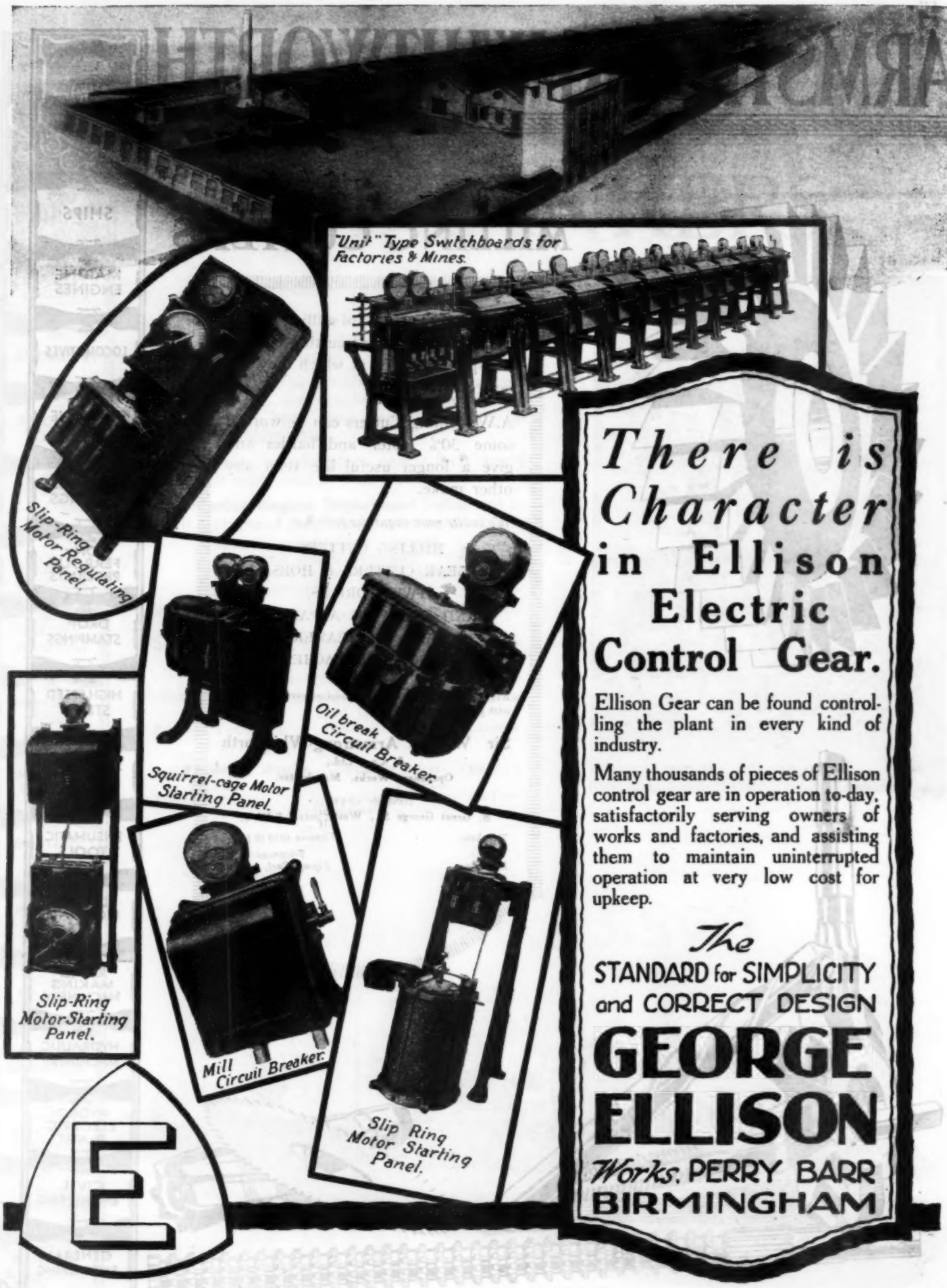
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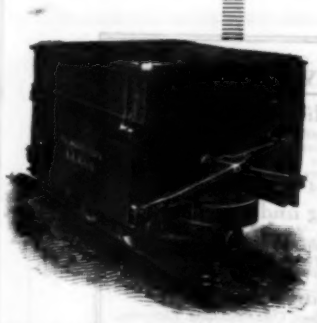

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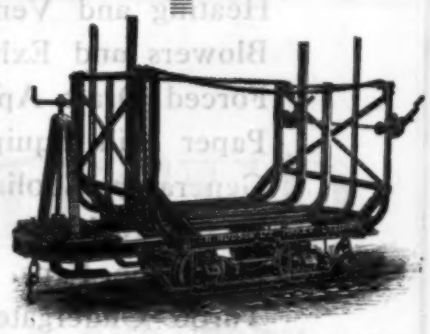

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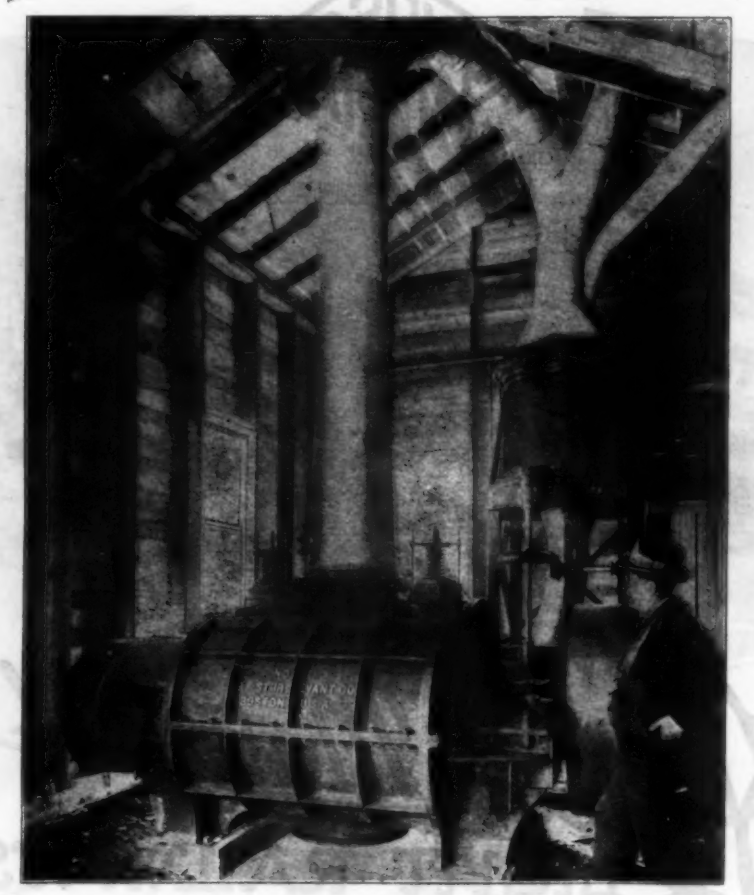

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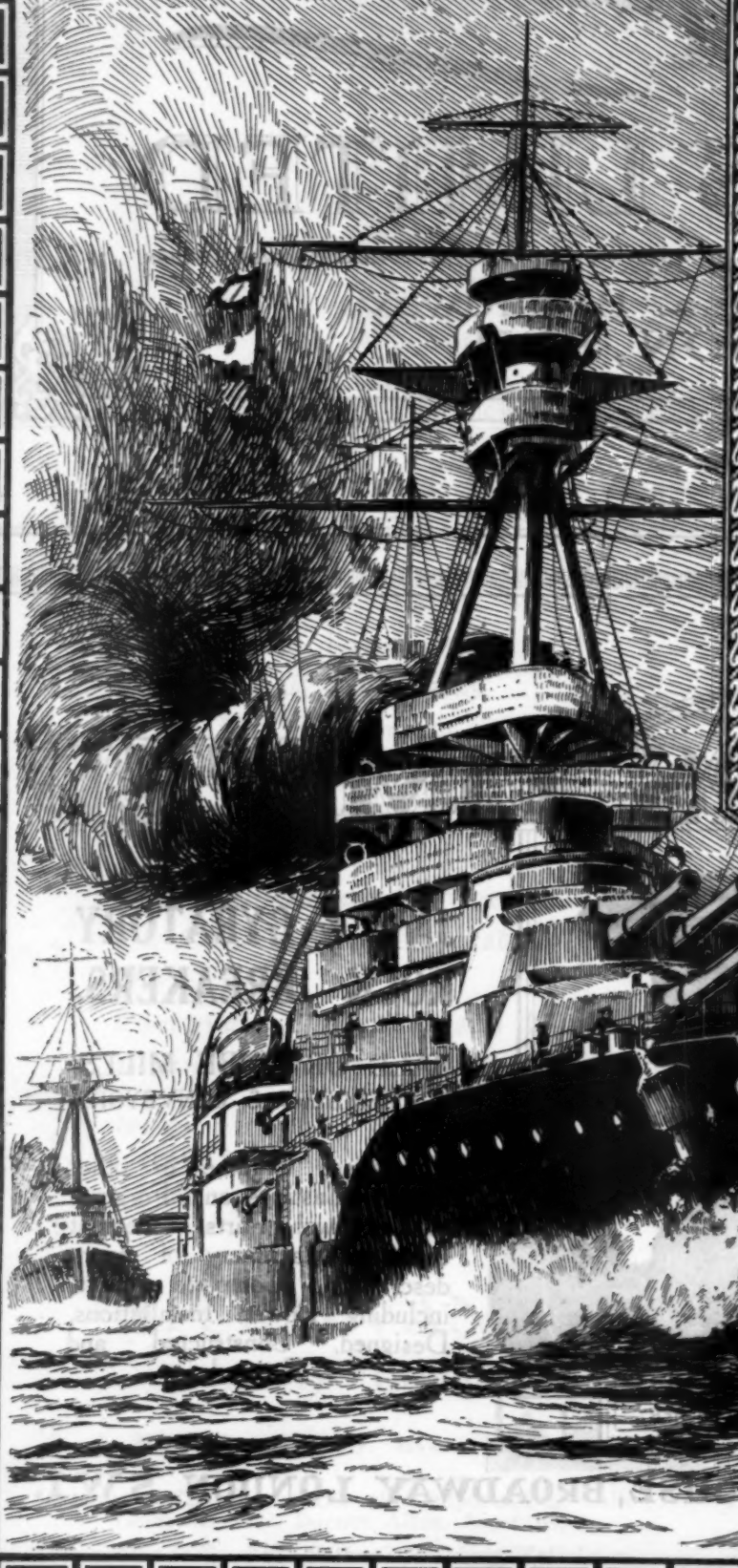

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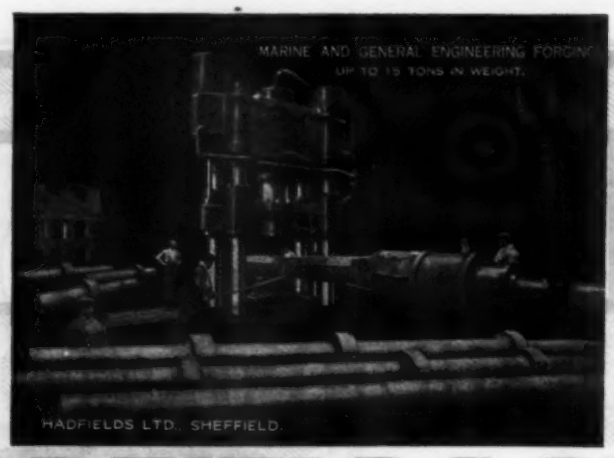

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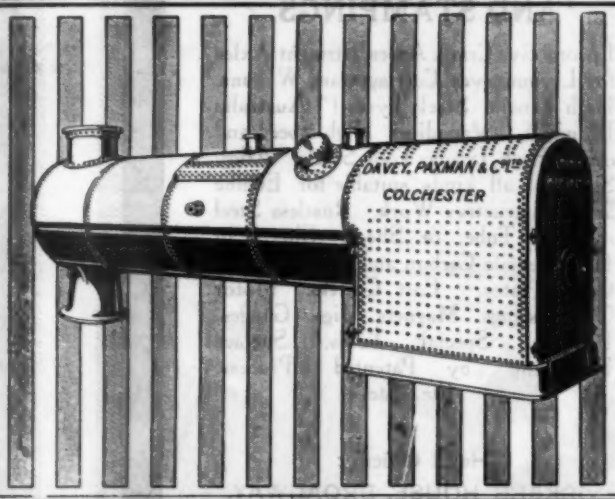

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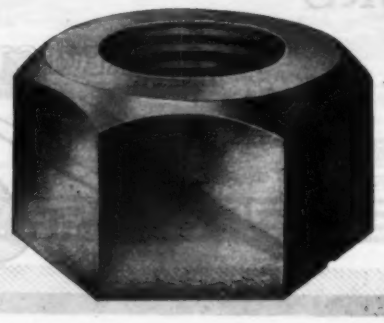

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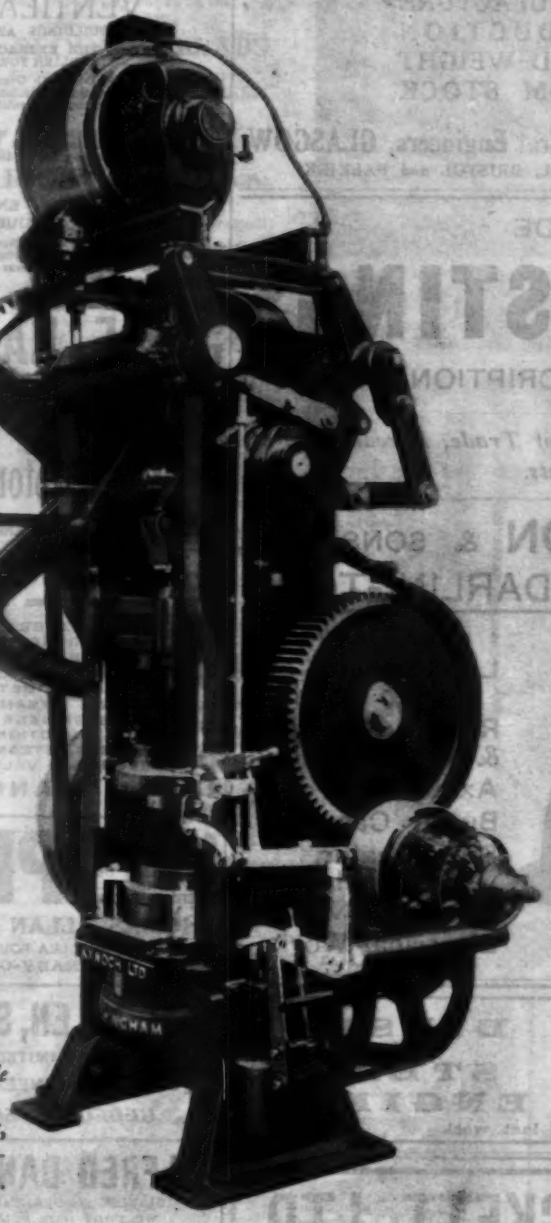

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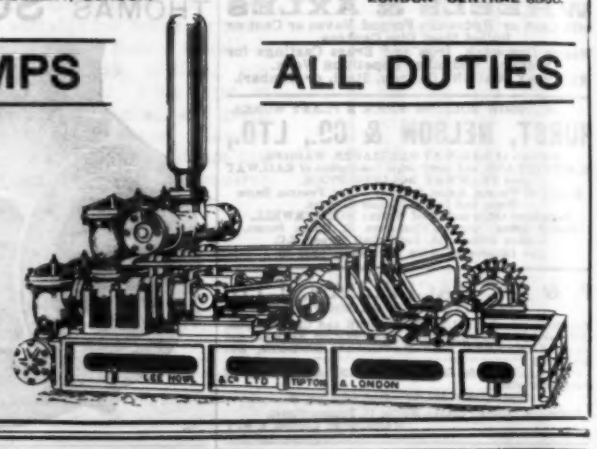

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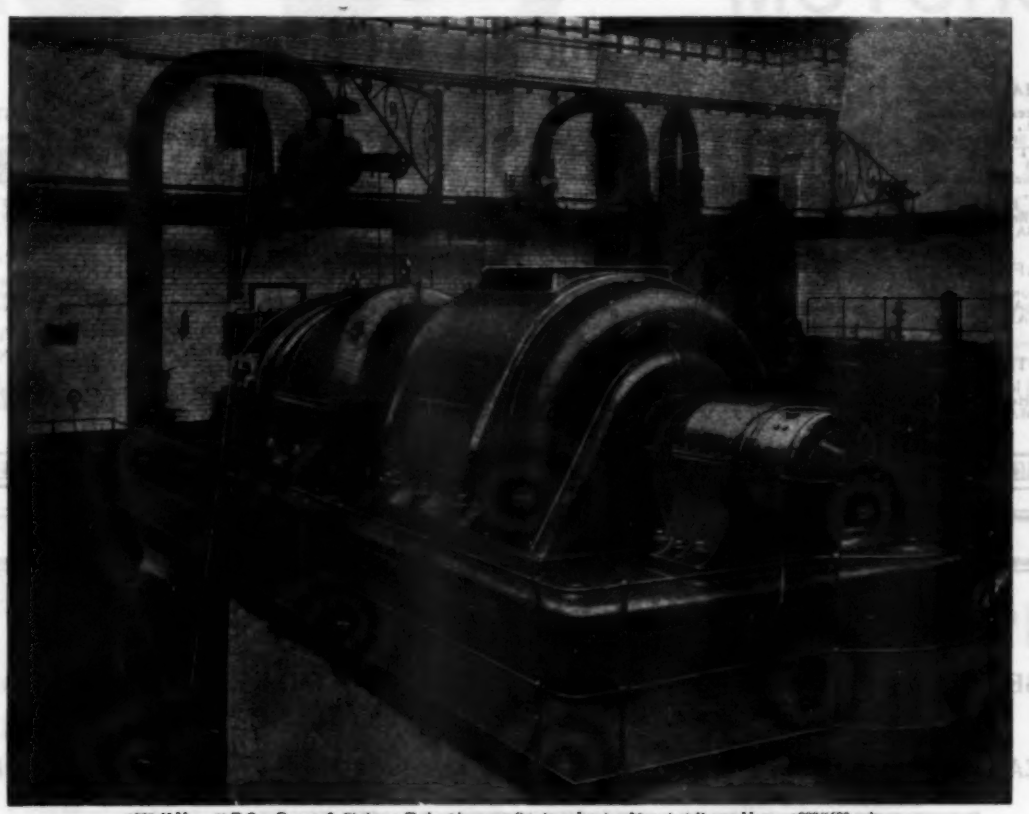

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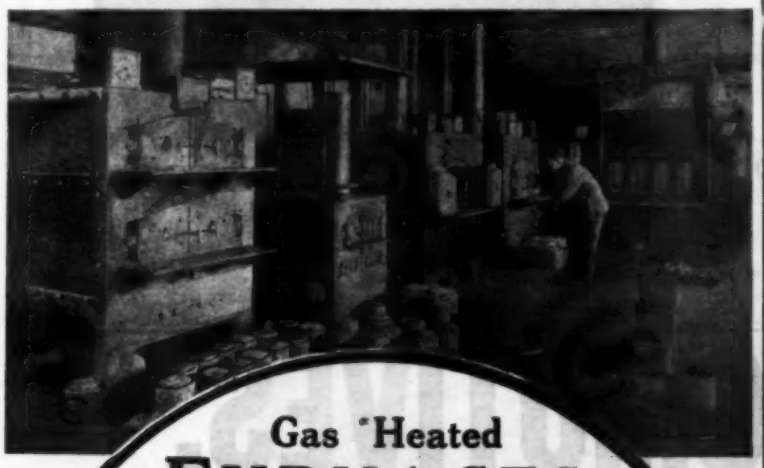

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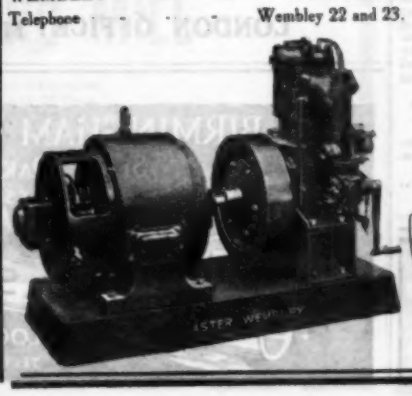

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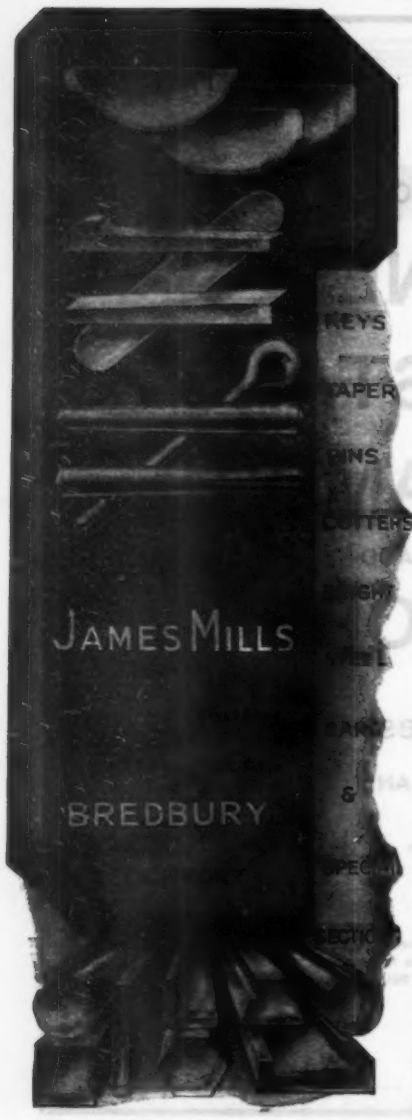

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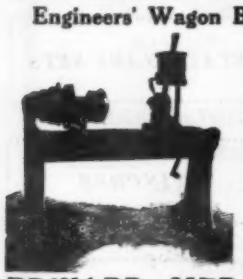

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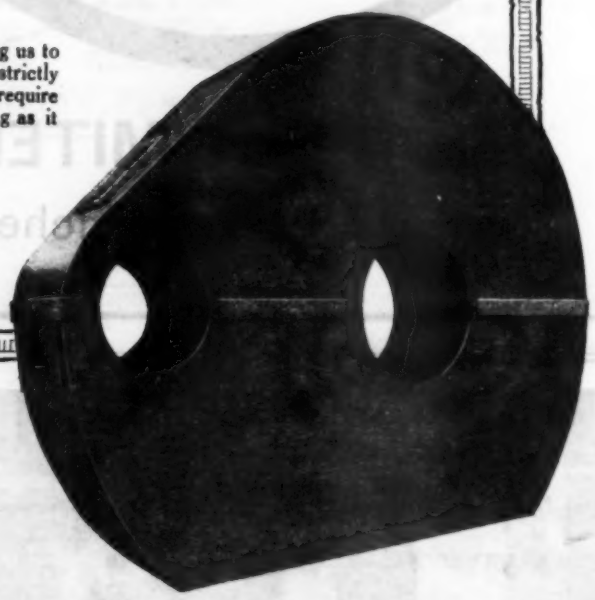

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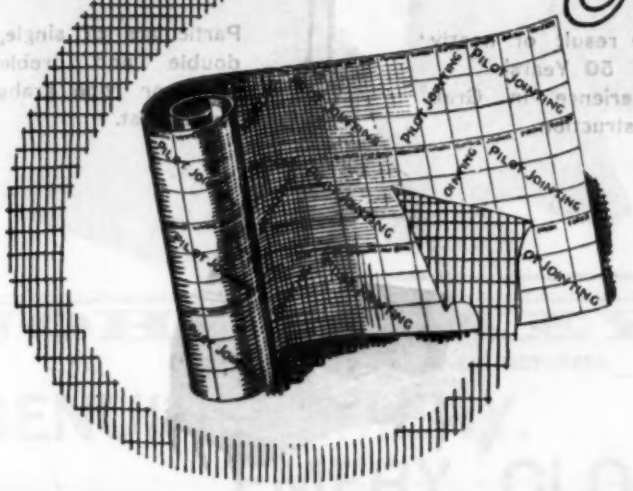

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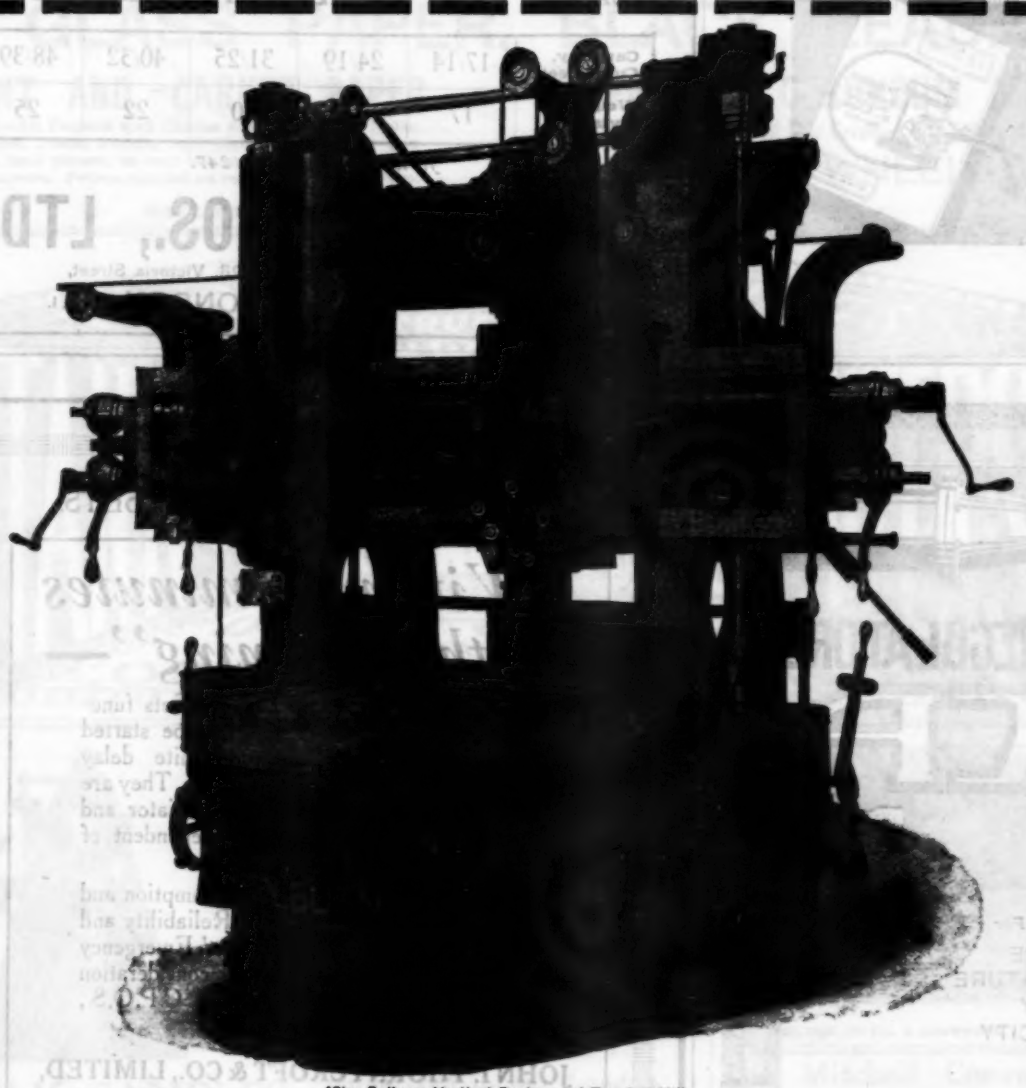

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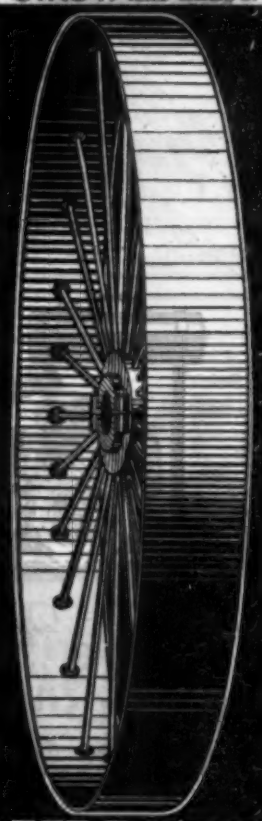

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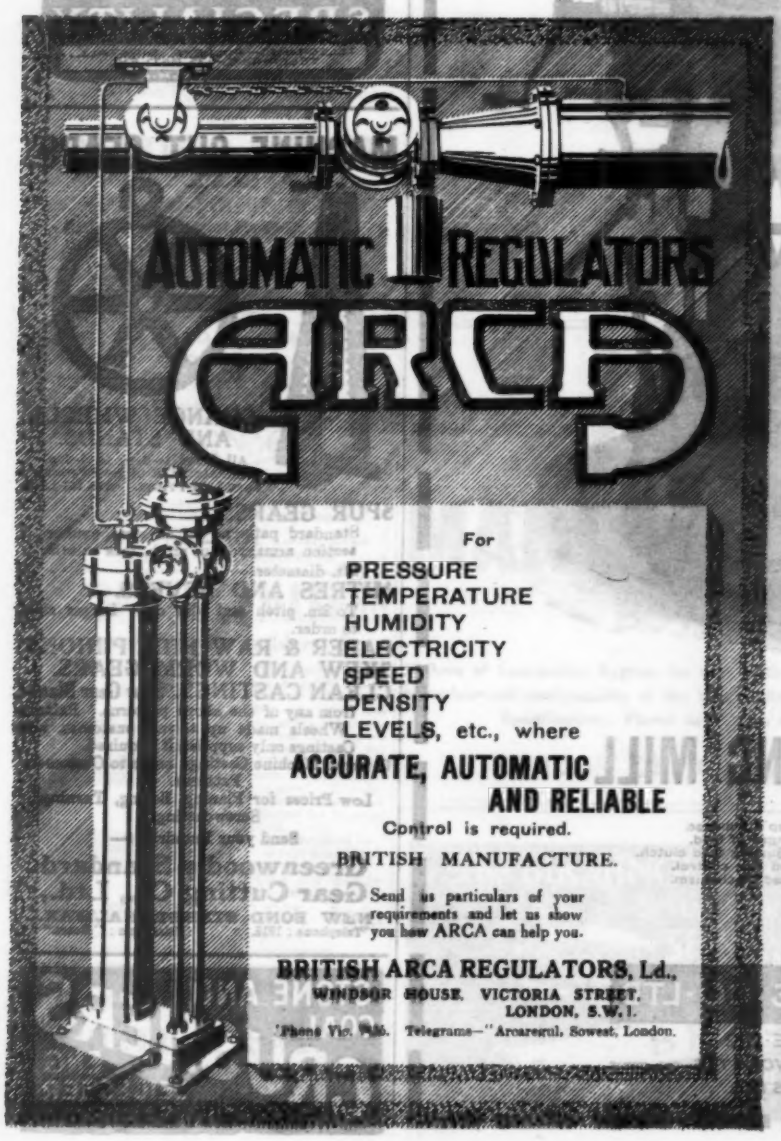

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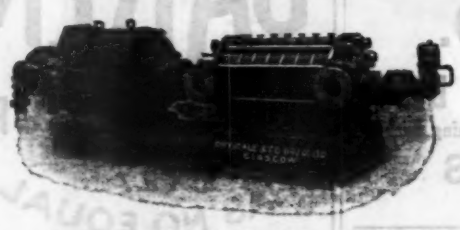

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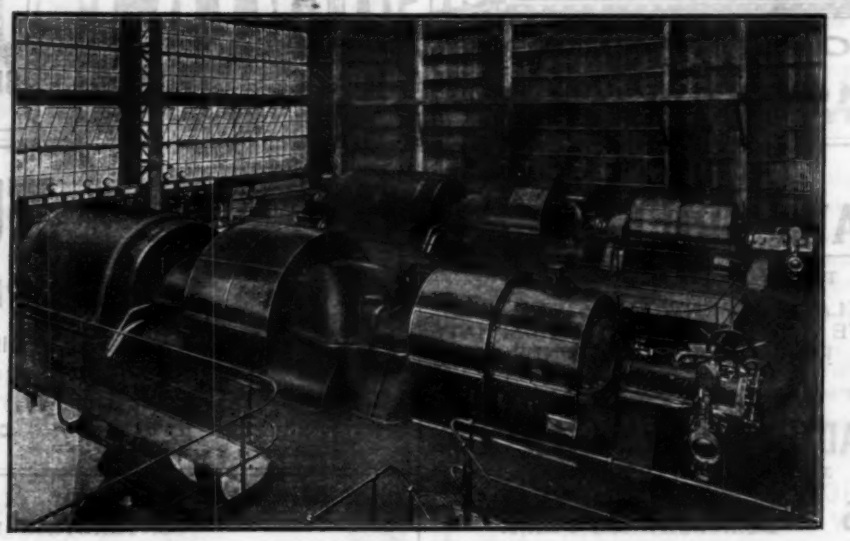

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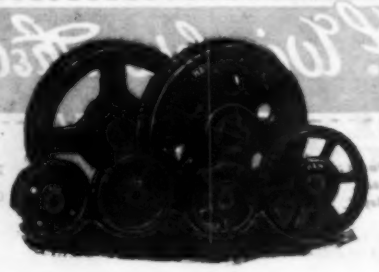

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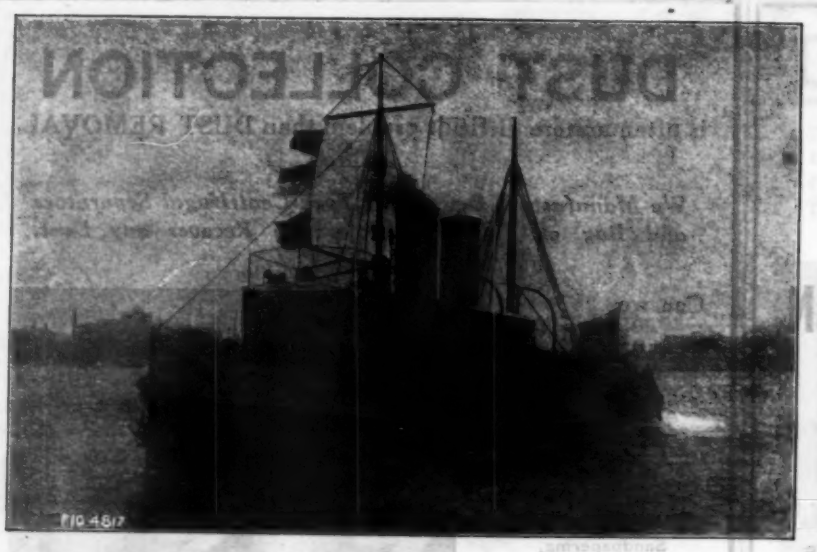

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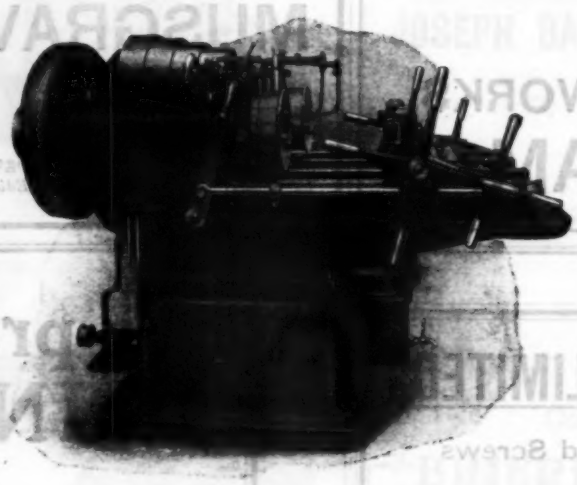

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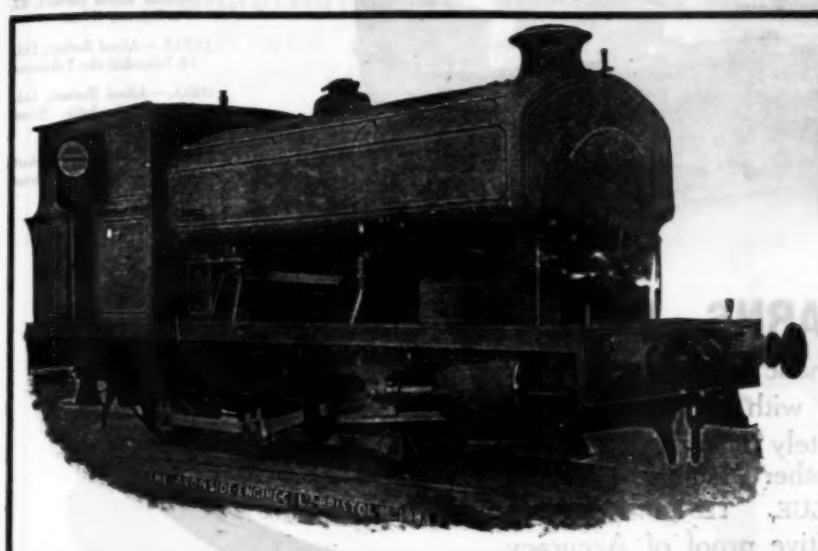

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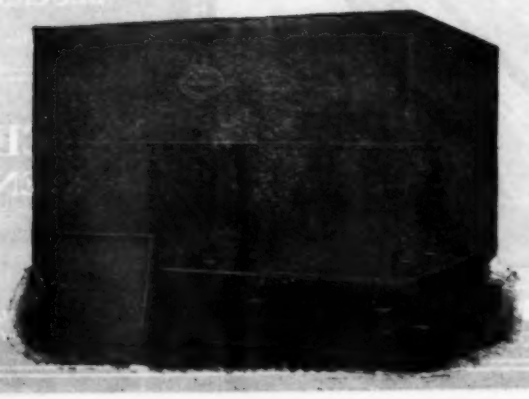

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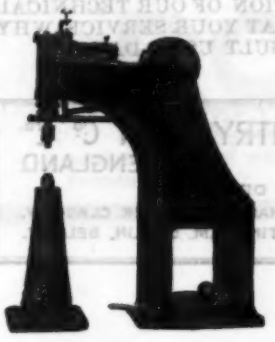

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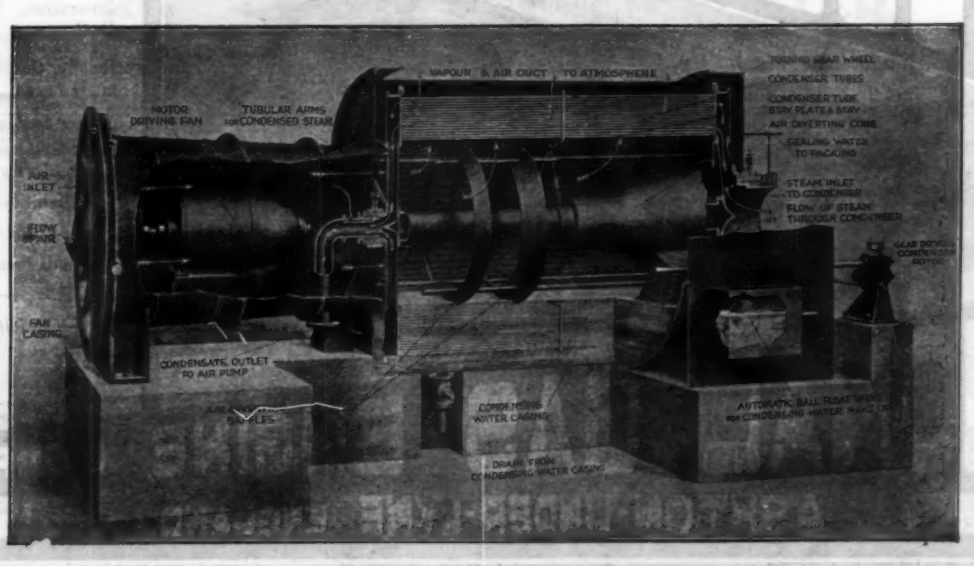

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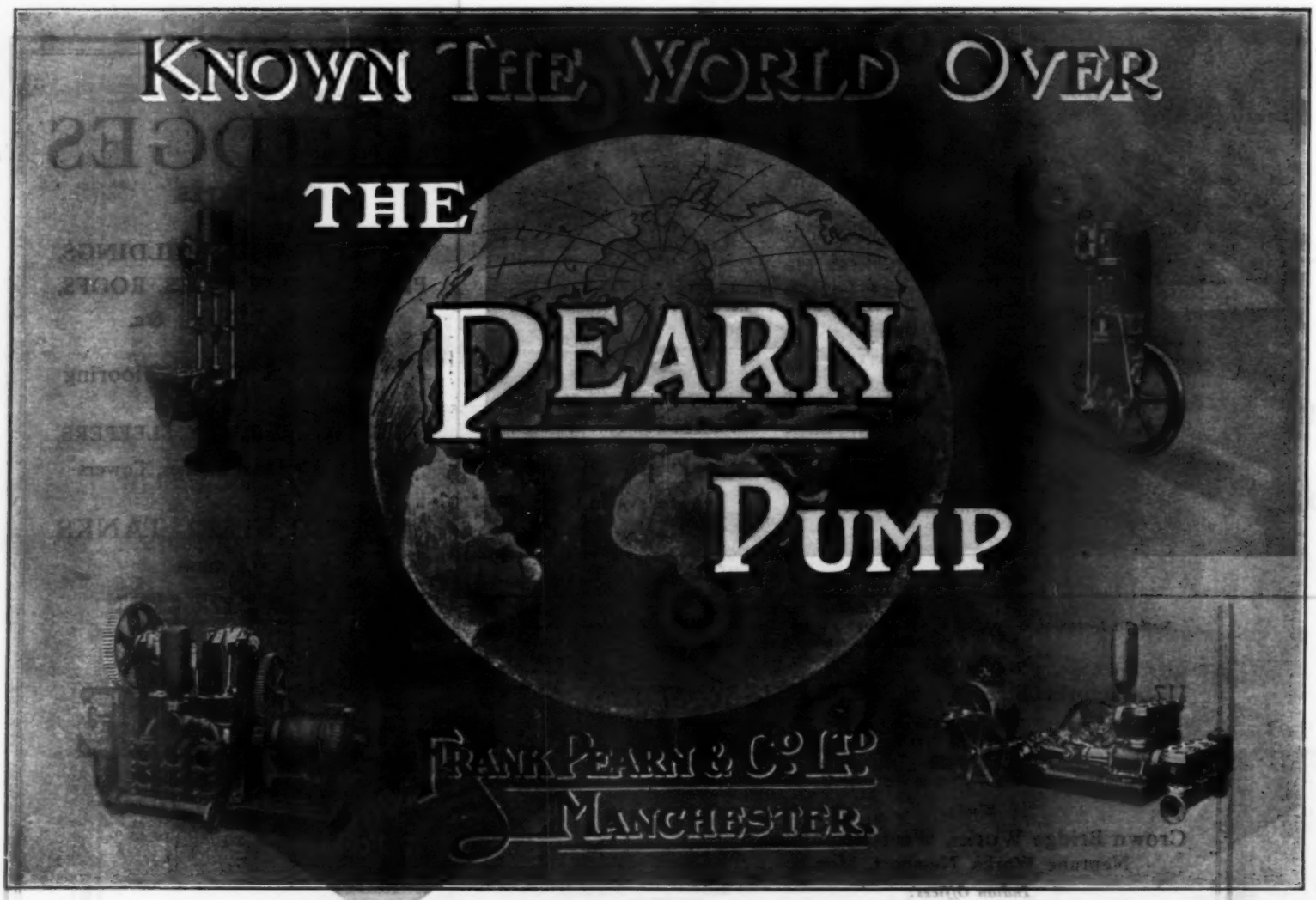

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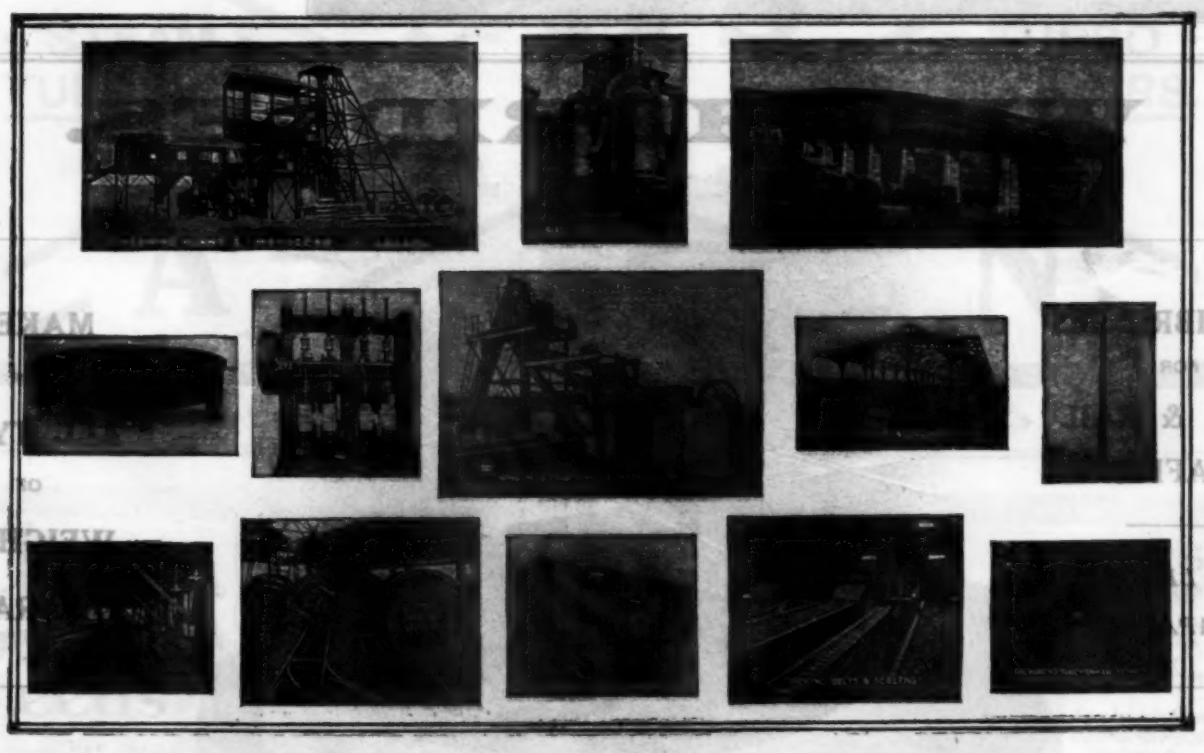

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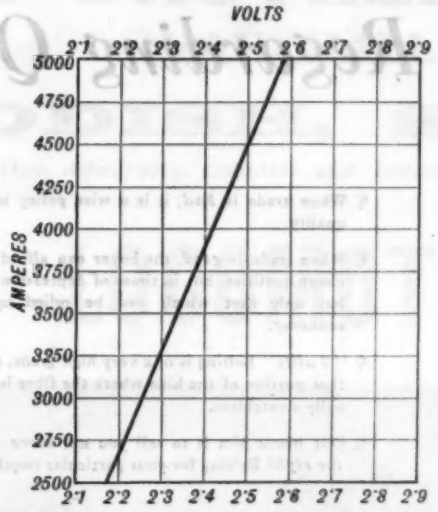

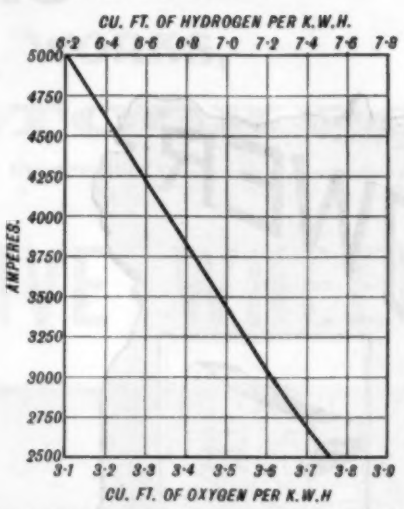

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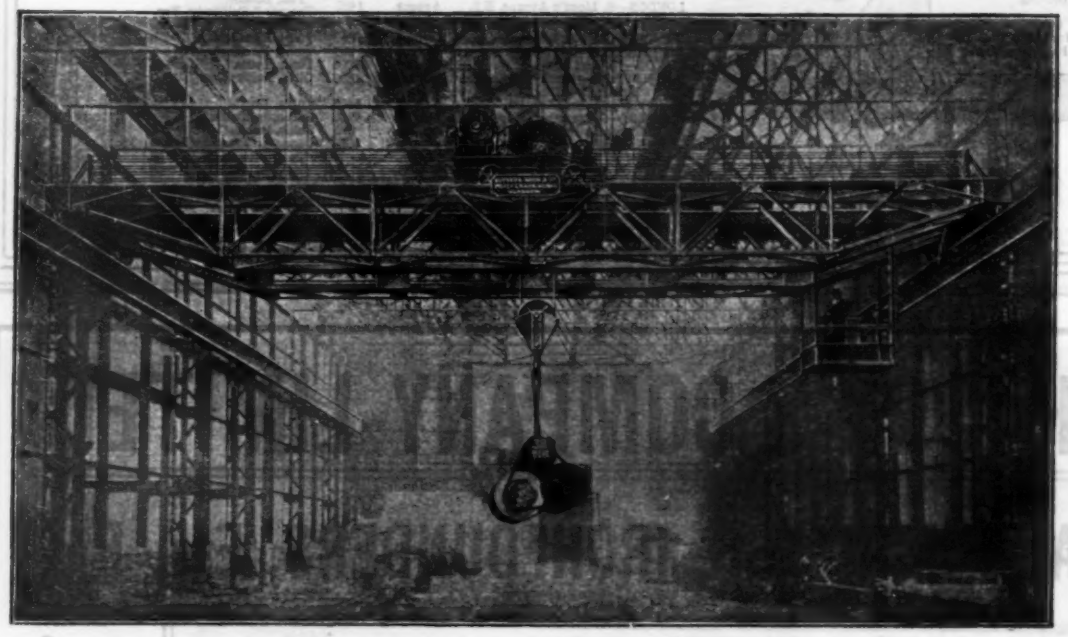

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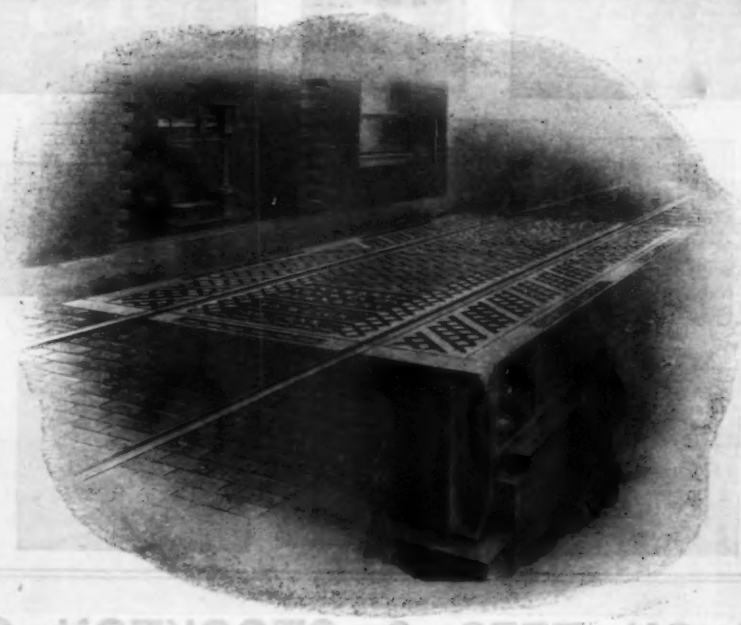

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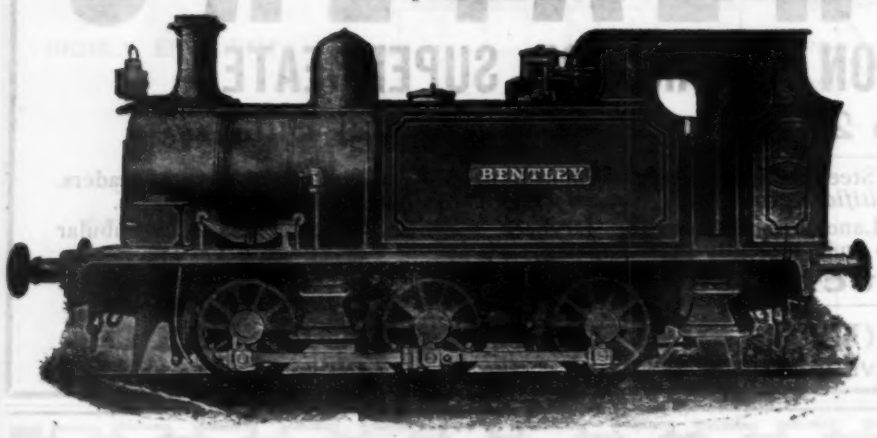

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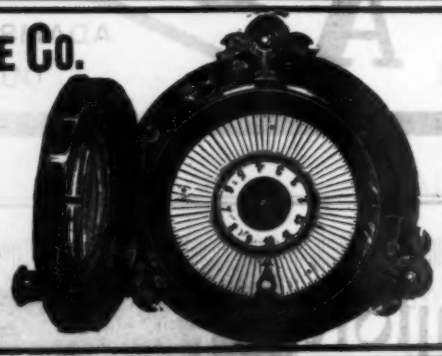

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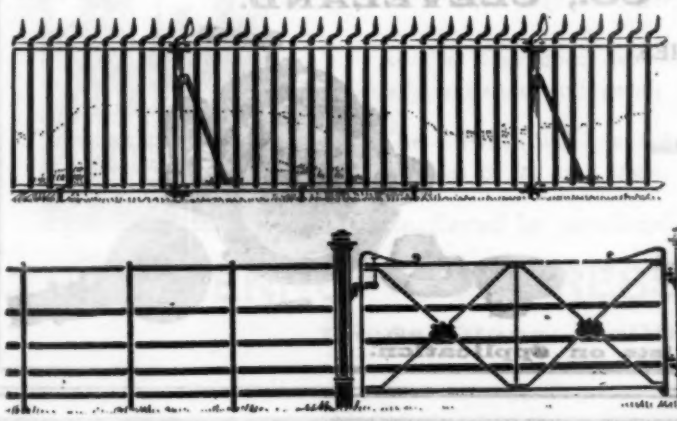

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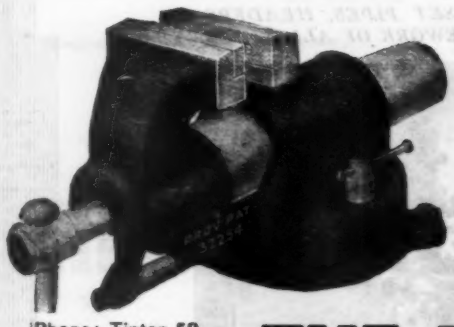

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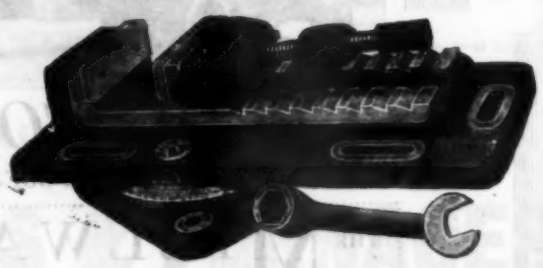

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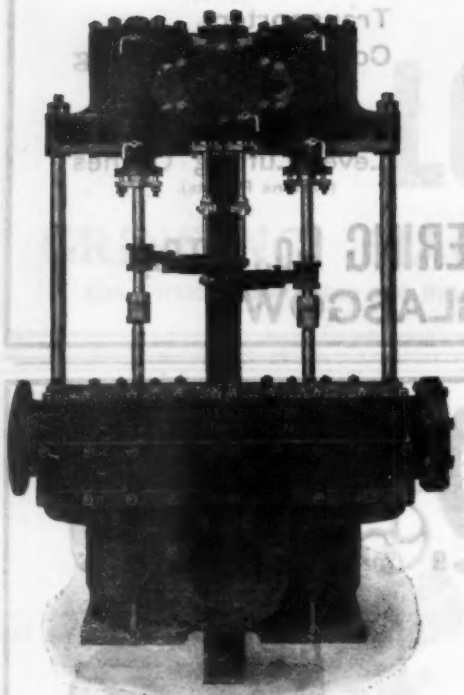

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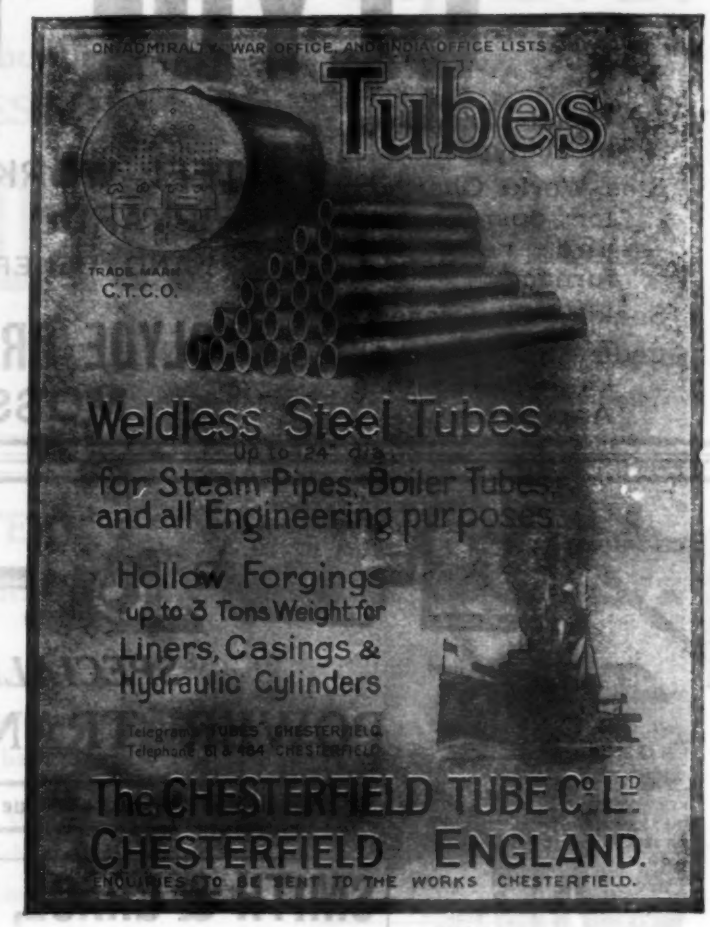

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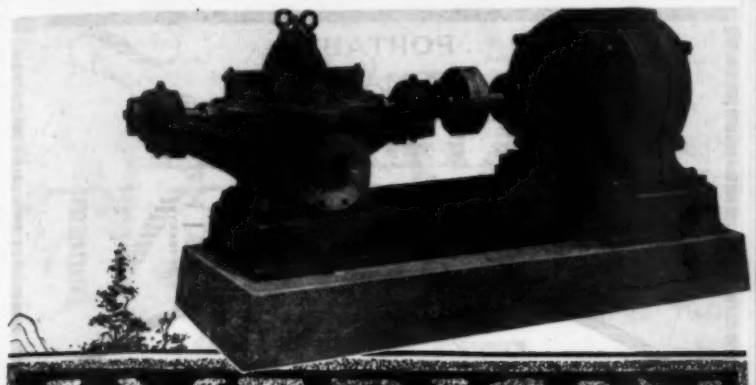

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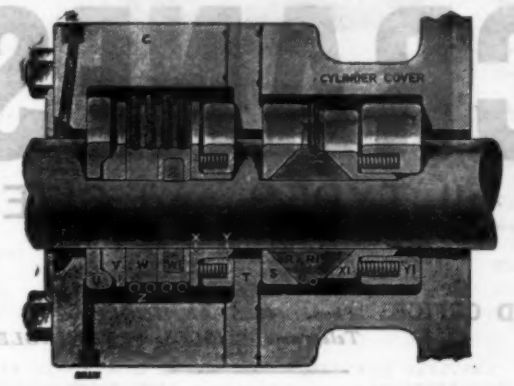

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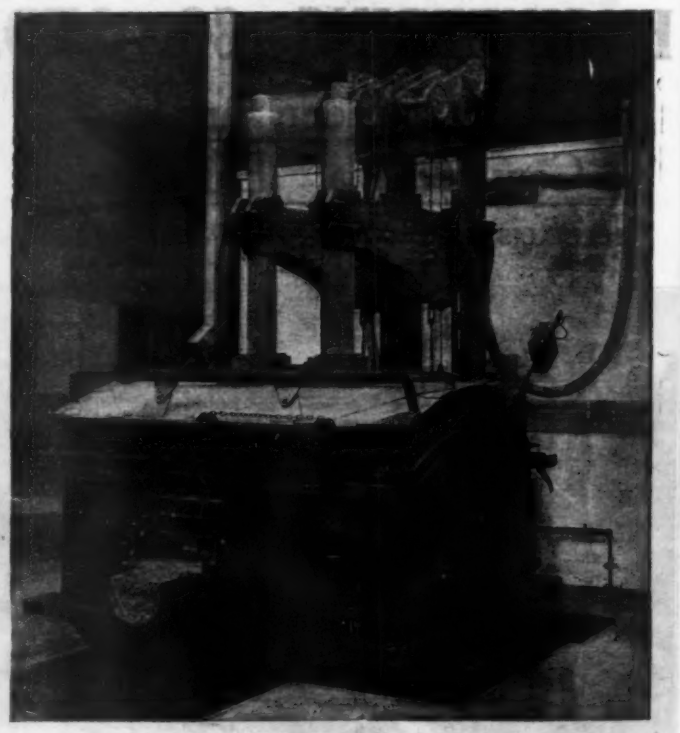

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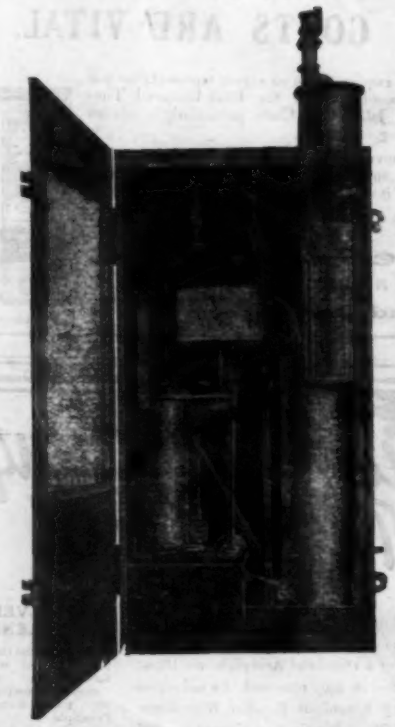

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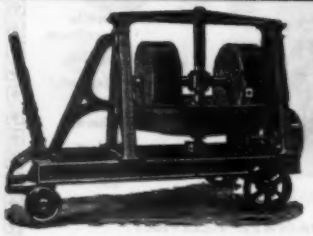

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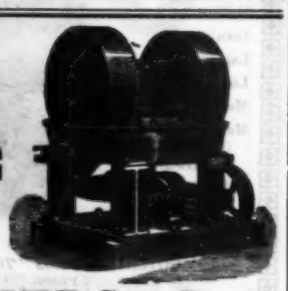

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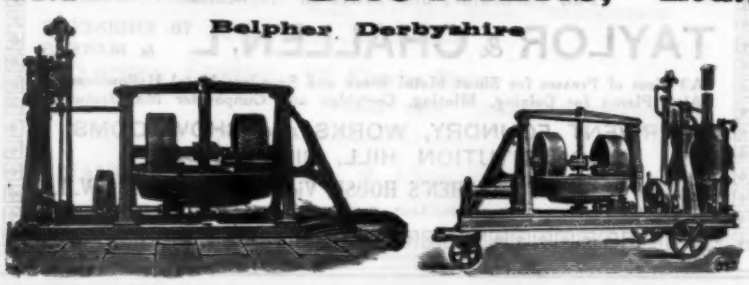

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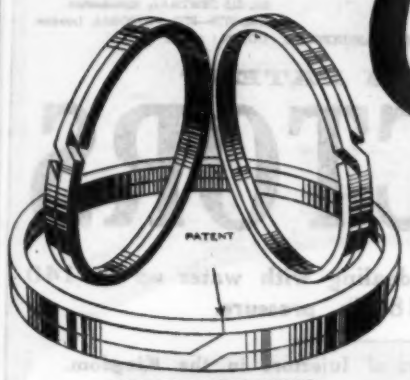

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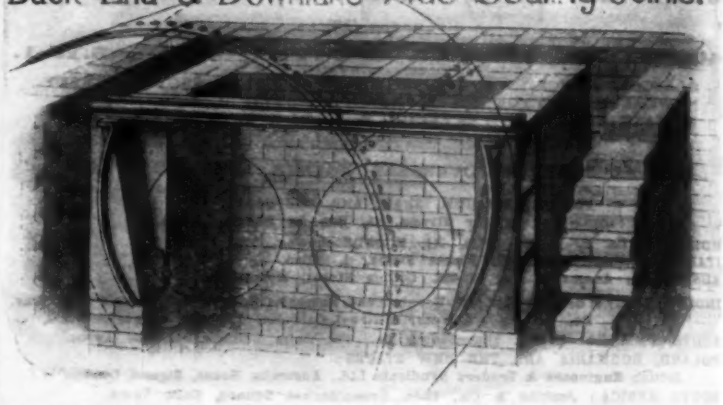

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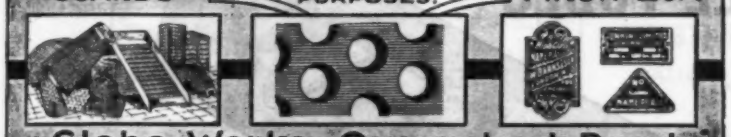

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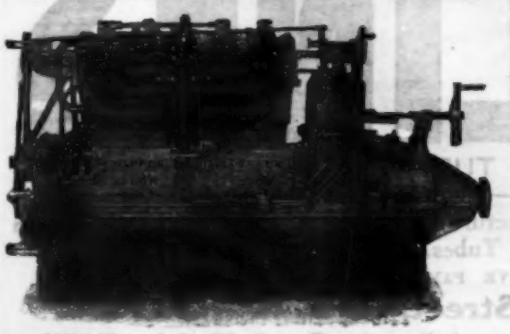

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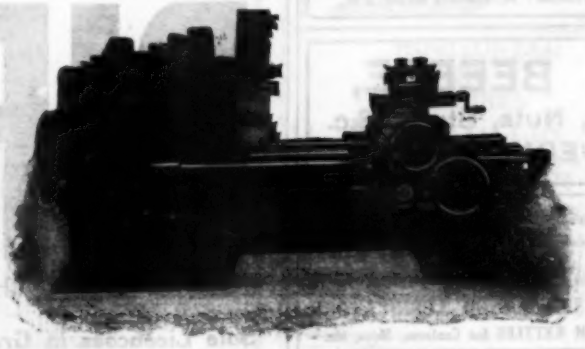

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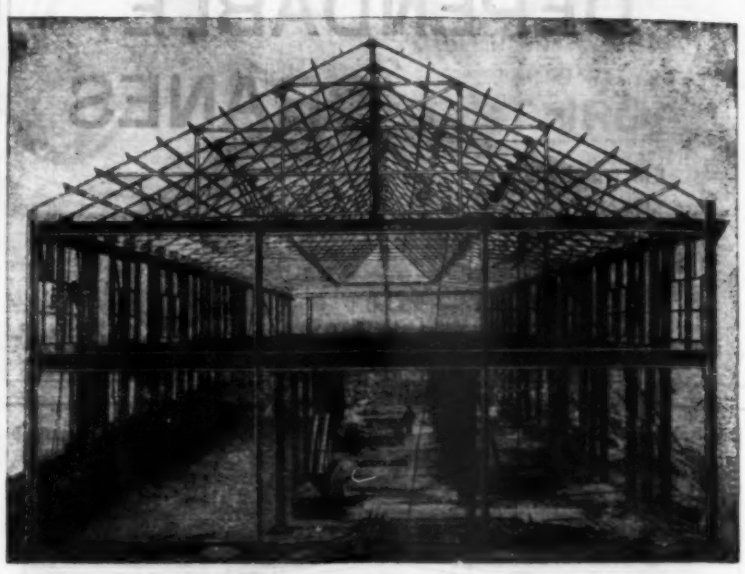

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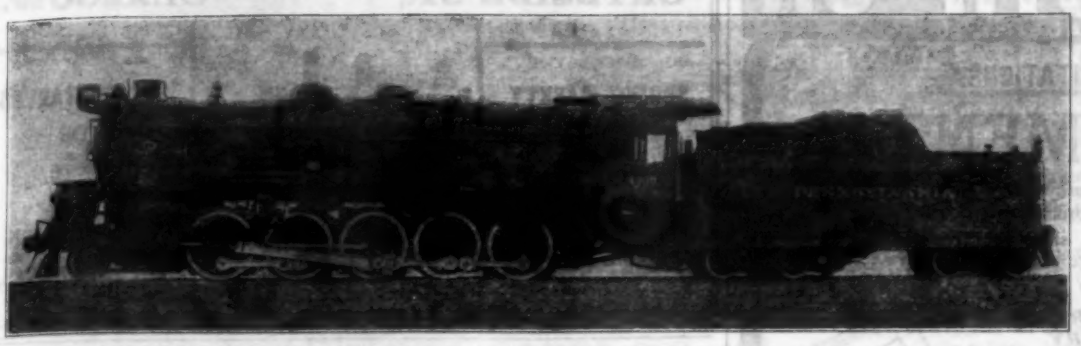

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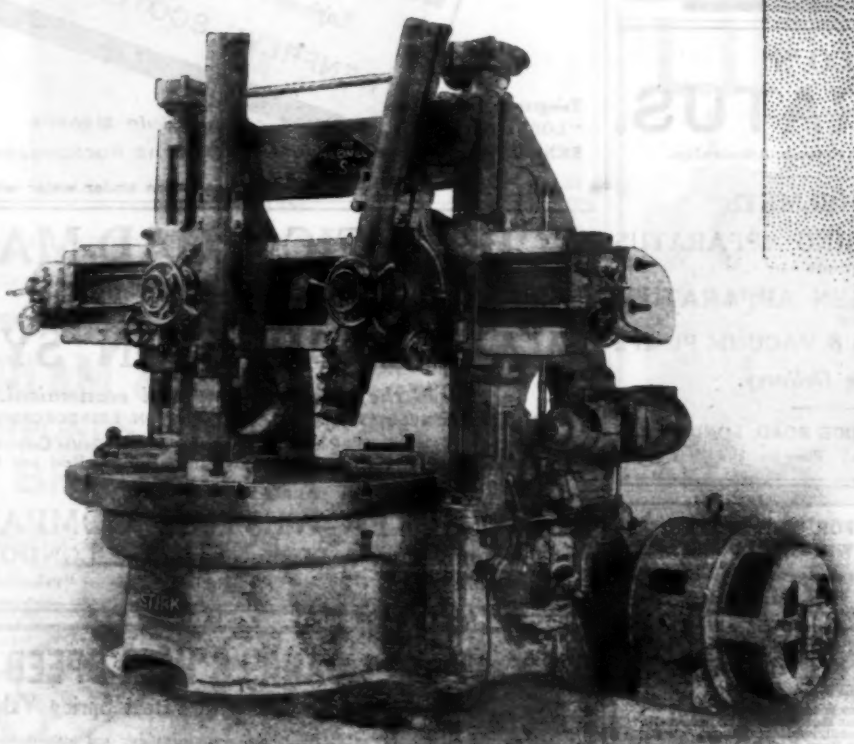

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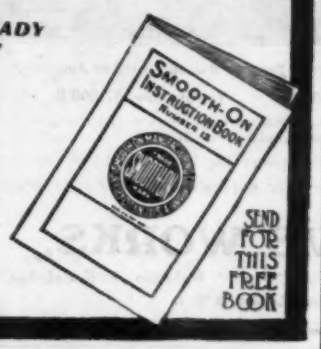

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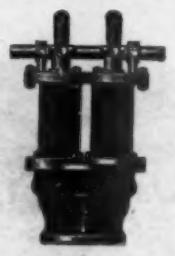

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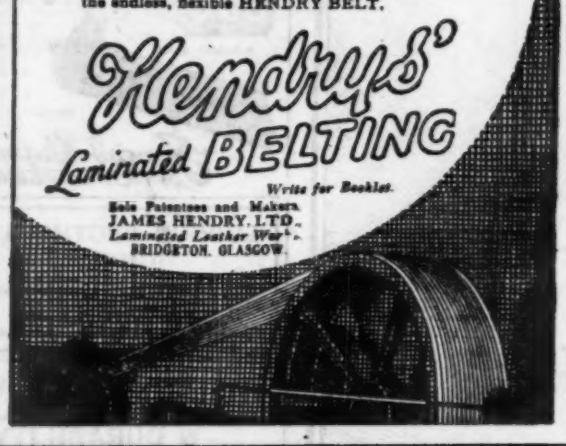

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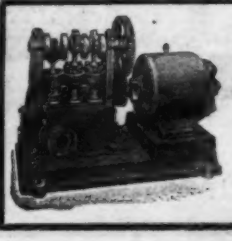

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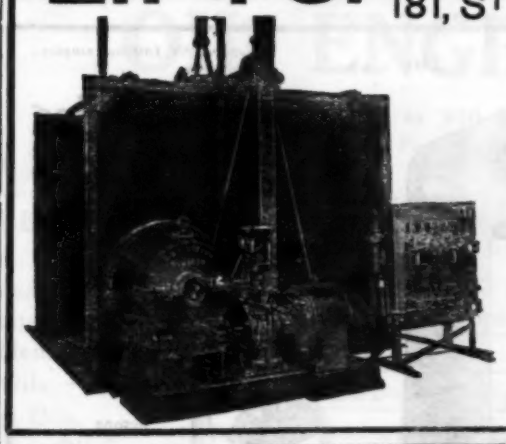

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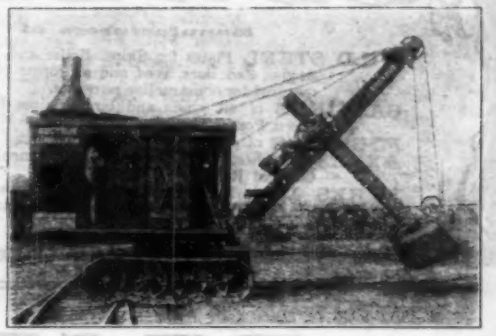

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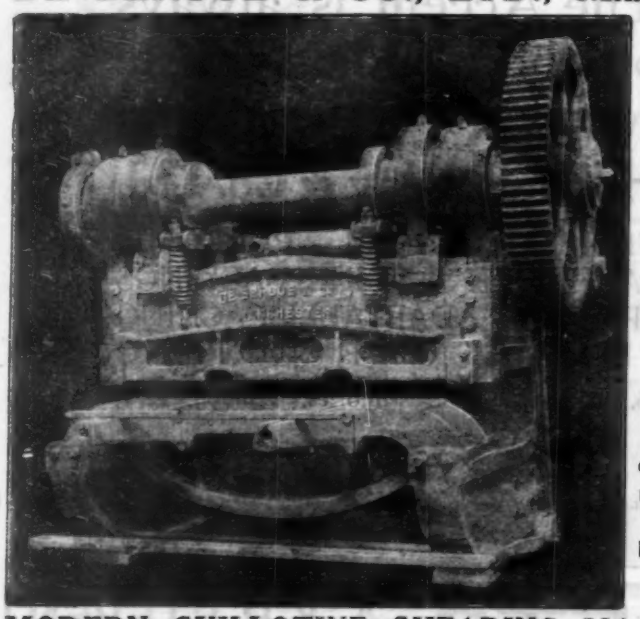

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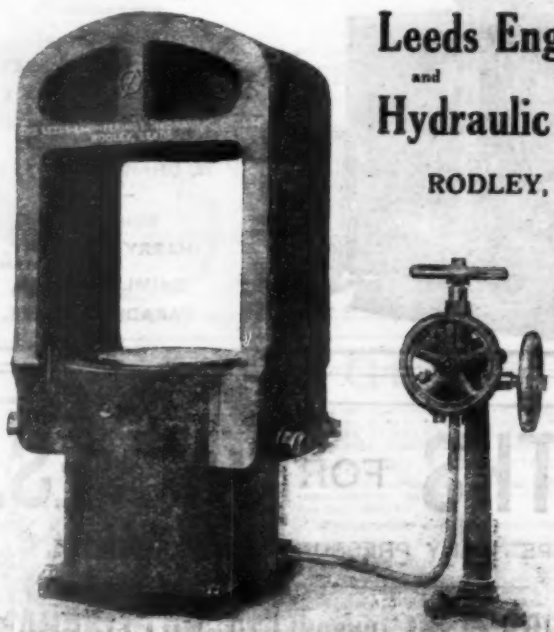

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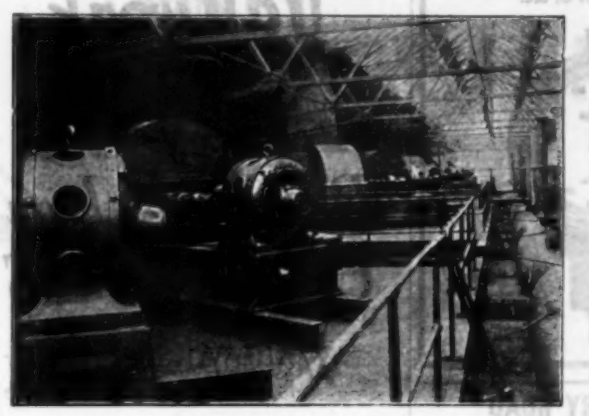

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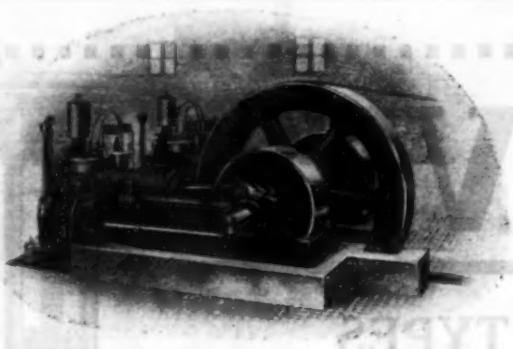

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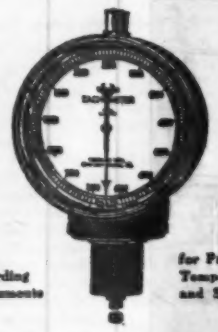

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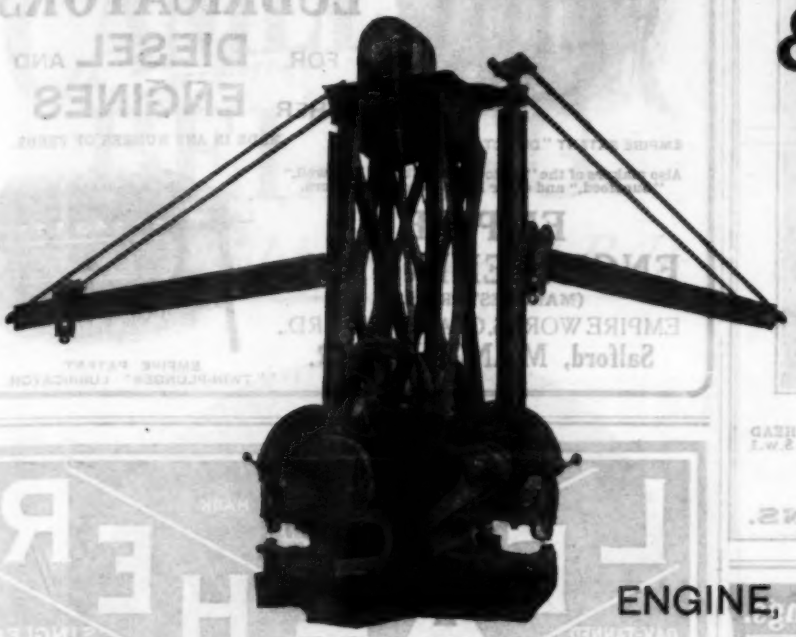

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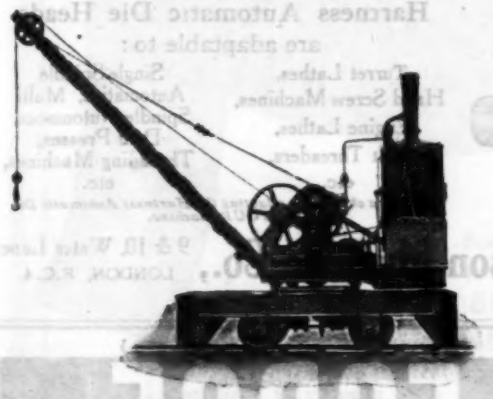

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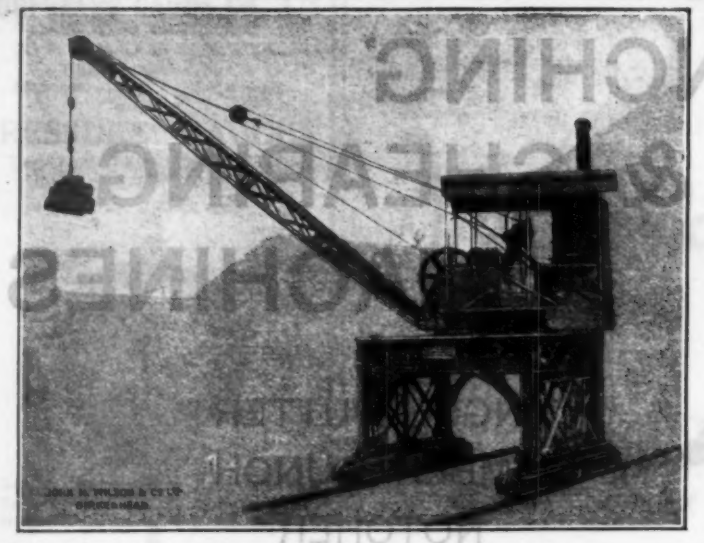

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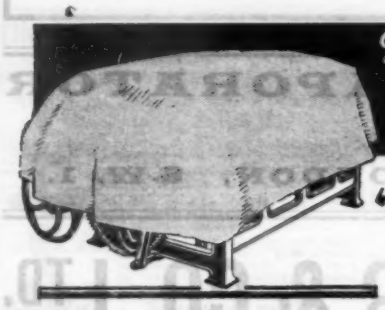

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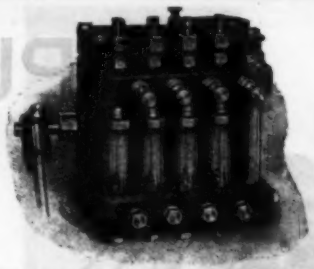

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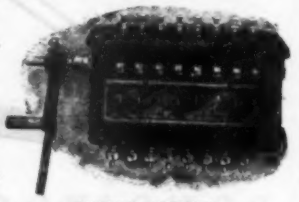

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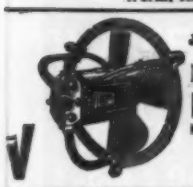

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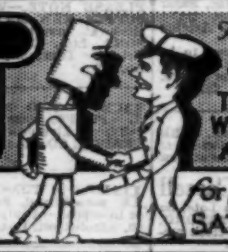

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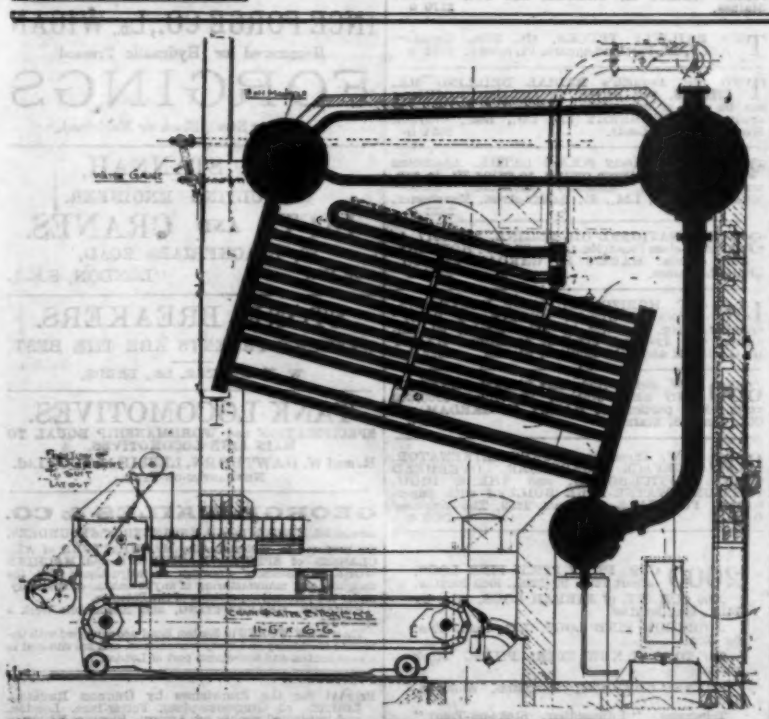

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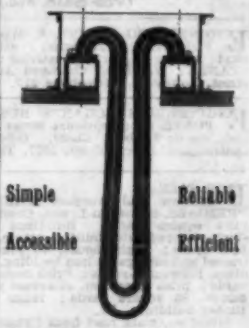

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Continued from Page 4

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